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WHEN GOOD FELLOWS GET TOGETHER

Donald W. Lentz, *President*

Humans have a very interesting facet—whenever two or more have ideas about the same subject, they want to get together and talk. Sometimes they will agree; more often they will not. Whether they agree or disagree, dispute or concur, they come away from the discussion with a feeling of satisfaction—a sense of growth. It is a good feeling that comes from exchanging ideas, isn't it?

Thus, many educators are finding the way to workshops, institutes, and other sponsored teacher-training programs during the summer and other "vacation" periods to swap thoughts. It was encouraging to receive letters from several of our Association members stating that they were participating in such programs, and to note that they were actively promoting the idea of membership in professional organizations such as the Central Association. Undoubtedly many others were also proving to their colleagues that professional affiliation has real advantages.

It is traditional that the Central Association provides stimulating opportunities for teachers to get new points of view and to "talk things over." For our annual convention at the Hollenden Hotel, Cleveland, November 22–24, every planning agency is working hard to make it worthwhile for our Association fellows to get together.

Dr. Donald H. Loughridge, Atomic Energy Commission, will "keynote" the meetings with his experiences in the Reactor Division as he considers "Education—The Primary Atomic Control." Dr. Elvin C. Stakman, Chief of the Division of Plant Pathology and Botany, Minnesota University, is certain to inspire his general meeting as he describes his recent experiences here (and, perhaps, abroad) with his exceptional means of expression. Dr. David Dietz, Science Editor, Scripps-Howard Newspapers, will add the perfect touch to a delicious

banquet with his unusual ability to discuss the future in terms of present achievements.

Add to this the many outstanding personalities appearing on the group and section programs and you have a perfect setting for good fellows to get together to discuss science and mathematics teaching. The Reservations Manager, Hollenden Hotel, is ready to reserve a place for you. Come, ***and bring friends!***

DEMONSTRATING THE INDEX OF REFRACTION OF WATER

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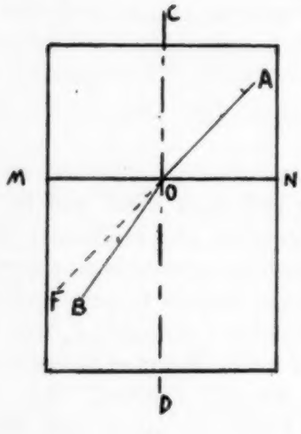
Light is refracted or bent as it enters or leaves the water because the speed of light in air is greater than in water. The index of refraction is the ratio of the speed of light in air to the speed in water. It can be expressed as the ratio of the sine of the angle of incidence to the sine of the angle of refraction which is numerically 4/3 or 1.333. A very simple way to illustrate this phenomenon is to draw on a piece of board a line to represent the water surface, a perpendicular line to represent the normal, the incident ray above the water line, the extension of the incident ray under water, and the ray of refraction under water. When the board is held in the water, the lines of the drawn incidence and refraction rays appear to form a continuous line, whereas the true extension of the line of incidence seems to bend.



MN—surface of water.
CD—normal line.
AO—incident ray.
OB—refracted ray.
OF—extension of incident ray.

Vinyl plastic window shades, available in several colors and sizes, add fire-protection to such desirable qualities as pleasing appearance and being washable, and are colorfast and rainproof. They will char but not flame.

LET'S TRAVEL THE ARKANSAS

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I like rivers. They are vital to life on this land of ours. As vital as the veins that circulate our life blood and make possible human existence upon the land.

They have personality even as you and I. Some are gentle, placid streams like the lovely Concord as it meanders on its northerly route to the Merrimack. Some can be made useful from their sources to their mouths, as the seven mile long Miami River in Florida, which is navigable for its entire length. Mighty Columbia generates the power which makes possible the agriculture and industry of our great Northwest. Generous Rio Grande gives and gives of its waters to aid the orchardists, truck gardeners and farmers of the central South. The rampant Missouri seems to take pleasure in roiling up Old Man River.

The Mississippi has one tributary which has always intrigued me. It is the Arkansas. As it flows for one thousand four hundred fifty miles to eventually reach its rendezvous with the great river, it reveals three distinct personalities that exemplify youth, maturity and old age.

The mountain torrent is the youthful river. In its upper reaches as it leaves the melting snows of the Rockies that gave it birth, the little stream has a clear, clean appearance. In its first one hundred twenty-five miles it plunges five thousand feet. Here it is noisy. It is often unruly. Frequently treacherous. Here it is thoughtless youth.

Youth enjoys a fight. This vigorous young stream once enjoyed a fight of such long duration that it might be called a war. The contest took place in the river's Royal Gorge. The river was not one of the participants, but two railroads, the Sante Fe and the Denver-Rio Grande, staged the grand affray. No conflict ever had a more imposing setting. In this four mile long canyon the red granite walls rise over one thousand feet above the surface of the water. At the base of the walls there was room for only one right-of-way. Both railroads were determined to use the route. This was the cause of the trouble. At long last the Denver-Rio Grande was declared the victor. The Arkansas had no actual part in the fight but it roared its approval vociferously as it flowed along on its way out of the gorge.

Youth usually feels there is gold at the end of the rainbow. In the case of this river, gold was to be found at the beginning of the rain-

Editor's Note: Miss Elliott has used rivers to create interest in geography in the upper elementary grades in the Cleveland Public Schools. The Arkansas is one of many that her classes have explored.

bow. Two Spaniards came a-hunting gold. They were De Soto and Coronado. De Soto searched the region near the mouth of the river, and Coronado hunted in its middle reaches. No gold was to be found. Little did they dream that three centuries later immense wealth would be found near the source of the river.

It was Americans who found the gold. Indians gave the first hint of the existence of gold in the Rockies to the Forty-niners enroute to the California gold fields. Accounts of actual deposits farther west were so attractive that they paid little attention to what the Indians said. Months later, disillusioned, penniless and weary, hundreds of these gold seekers were back in the Rockies once more. Then they recalled what the Indians had told them. Gold could be found here! Some stopped. They went to digging.

About this time eastern United States was having financial difficulties. Business was at a standstill. Men were searching for work. Fantastic stories of gold to be found in the Rockies, lured many into Colorado. Prospectors hunted. Miners dug. Some were successful. Some were not. Leadville, the first settlement of any size along the Arkansas, was the goal of every miner who struck pay dirt. What celebrations were held in that town of Leadville in the nineteenth century!

—All this time the river was a-growing and a-flowing toward the Mississippi—

The youthful Arkansas has accepted little responsibility thus far. It has largely been an observer. But changes are in store. The river comes to the realization of this fact for the very earth over which it is flowing gradually levels off as it enters the Great Plains region. Left behind are the snowy Rockies from which it sprung. Playtime is over. The turbulent river becomes more tranquil.

Soil, weather and water now attract orchardists to its banks. For a stretch the apple and cherry are supreme. Farther on is an industrial area about Pueblo, Colorado's Pittsburgh, where smelters and iron and steel foundries rear their smokestacks along the river. Beyond this city and on into Kansas, soil, weather and water again captivate those who are interested in growing things. This time it is the truck gardener, sugar beet grower and the farmer. Alfalfa and wheat, cantaloupes, honey dews, watermelons and vegetables. It is here the river really goes to work irrigating the land. In the distance cattle are grazing, for this is cow country too. The Arkansas has seen buffalo where cattle now graze.

Adventure attracts many men. This part of the river has had its moments of high adventure. There were two who came early. Passed on. Then came back time after time. Kit Carson and General John

C. Fremont were these early visitors. Here bad men of the west sought refuge. Dodge City was the end of the Texas Cattle Trail. In Dodge City cowboys celebrated as the miners did in Leadville.

—And the Arkansas kept a-flowing and a-flowing to the Mississippi—

In Kansas the Arkansas suddenly veers to the northeast as if it wished to travel to the Missouri, but it does not go far in that direction. At the town of Great Bend, it again turns to the southeast. Oil derricks have been appearing along the horizon but from now on they become a definite part of the landscape. Oil is king along the river from here to near its mouth. The good earth is prodigal with its gifts along the stream. Hutchinson, Kansas, is built above salt deposits. Here salt is mined, processed and shipped. Hutchinson boasts a laboratory where salt is tested and new methods for purifying it are constantly being devised. Out around the city are oil and wheat.

Wichita is the next city through which the river flows. Here you might say the Arkansas makes a gift to a neighboring river, the Colorado. For some years most of the trail mules used to explore and travel the Grand Canyon have been bought and sold at Wichita. To this town the farmer brings his produce and here he purchases his necessities. Here airplane industries are becoming increasingly important.

Few tributaries of any size enter the Arkansas in Kansas. Oklahoma seems to realize that the stream has reached the point where it needs assistance if it is to attain its goal. So into the Arkansas it pours the waters of the Verdigris, Nesho and Illinois from the north and those of the Cimarron and the Canadian from the south.

De Soto unsuccessfully searching for yellow gold would have been astounded to know of the existence under his feet of such a substance as black gold. Back and forth he tramped over one of the greatest pools of petroleum to be found in our United States. A city with the slogan, "Oil Capital of the World," is located along the banks of the river in this area, Tulsa, Oklahoma. This city's claim to this title lies in the fact that within the city limits oil is mined; oil is refined; oil production is financed; oil is taken from fields to laboratories to improved methods of production; oil equipment is manufactured.

—And the Arkansas is still a-flowing and a-flowing to the Mississippi—

After it leaves Tulsa the land on either bank becomes higher and higher until the river finds itself with Ozark Mountains and Plateau on its north bank and Ouachita Mountains on its south. In these

areas are National Forests. Some distance from the river, but in the Ouachitas, is Hot Springs National Park, the only hot springs health resort operated by our Federal government. Clear streams, waterfalls, fish give recreation facilities for people in both areas. This is fine berry and poultry country.

It was during the early part of the nineteenth century that the Arkansas came into its own as a means of transportation. People had the western fever. Here, just as on the Ohio River, the keelboat was queen of the waterways. About this time Fort Smith near the boundary line between Oklahoma and Arkansas was settled.—Lum and Abner with their country store came from a little distance south of the river here. Van Buren boasts of Bob Burns and his bazooka. These men are gifts to the radio.

The jaunt through the mountains and plateaus has been quite a stretch and as the river flows out of this area and onto the prairies and across the alluvial plain into the Mississippi it slows up like an old man who is tired and ready to rest. The level fertile soil of this area along the river is producing rice, cotton, soybeans, corn and alfalfa.

Here the Arkansas's chief pride is Little Rock. This city is not only the capital but the metropolis of the state of Arkansas. Lumber processing employs many people. It is a cotton market. Bauxite is almost as important to Little Rock as oil is to Tulsa. Processing alumina and aluminum products is a major industry.

At Arkansas Post thirty miles from its confluence with the Mississippi is the oldest white settlement on the river. Established by Henri di Tonti in 1676, it has had a long life along this stream. At the old town let's pause and let the river reminisce.

It is an old river talking, "As I recall the first people to come to my banks were the Redskins. They remained a long time. In fact, they staid until driven out by the Whiteskins. There were several different types of white men who came. Spaniards were the first to find me. Then came the French. These people were hunters, woodsmen, trappers and explorers. Last to come were the Americans. They are still here.

"Many famous in American History have visited my banks. If you could delve deep enough in the mirror of my waters you might see reflected the face of Zebulon Pike who mapped the course of my waters from my mouth to Colorado, or, Daniel Boone who came wandering by and during his wanderings found the first prehistoric ruins in the state of Arkansas. Two men of Texas fame paused along my banks,—David Crockett and Samuel Houston. Not far below the surface of my waters you may see the reflection of a lad's face.

This boy was born and lived in Little Rock as a child. His name, Douglas MacArthur!

"I have given and am giving much to my country to make it the great United States that it is today,—gold, silver, lead, fluorspar, oil, gas, bauxite, and the fertile soil. May these be used to make a still better life in this great world of today, as I go to meet the Mississippi where I shall still go on a-flowing and a-flowing."

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REVISION OF BY-LAWS

Revisions of the By-Laws of the Central Association of Science and Mathematics Teachers as proposed in the October, 1950 and November, 1950 issues of this *Journal* were adopted by the membership at the 1950 annual business meeting. However, at the request of the Nominating Committee and the Policy Committee, the president appointed a committee to review Section 2 of Article III and Section 4 of Article V. This committee sought the opinion of past officers, members of the previous committee on revision of the constitution, and members of the present Board of Directors, and now present the following recommendations, to be considered at the annual business meeting this November:

1. That Section 2 of Article III be amended to read: "Nominees for the office of president and vice-president must have been officers and/or members of the Board of Directors within the past five years."
2. That Section 4 of Article V remain as revised last November.

Members of the present committee are Lenore John, The University of Chicago; John R. Mayor, The University of Wisconsin; John E. Potzger, Butler University; W. R. Teeters, Board of Education, St. Louis, Missouri; Marie S. Wilcox, Chairman, George Washington High School, Indianapolis, Indiana.

A GENERAL SCIENCE TEACHERS ALMANAC

Raymond F. Cahalan
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Science teaching can be far more effective if proper materials are on hand when needed and if advantage is taken of seasonal materials when they become available. All this requires a bit of over-all planning early in the school year—even before if possible.

The following "almanac" may help teachers anticipate some of their needs. Based on a month by month program for the North-east it may be revised readily to fit other regions.

Pre-School

Locate nearby parks, ponds, meadows and woods.
Call the business offices of local industries to investigate the possibilities for trips.
Make a catalog of the science books available in local public libraries.
Write for examination copies of new textbooks.
Inventory science equipment and supplies and order new items.
Check the supply of hand tools, and order new items.
Make up a schedule for rented films.
Procure an almanac.
Write to the United States Weather Bureau and arrange for the daily weather map service.
Write to industries that provide services to science teachers and ask to be placed on their mailing lists.
Pay your dues in your local and national science teachers organizations.

September

Ask pupils to build up a supply of clean tin cans of various sizes, glass jars, flower pots and the like.
Locate common trees while still in leaf and easy to identify.
Set up a shadow stick or its equivalent on the day of the autumn equinox.
Begin a series of snapshots showing shadow change with seasonal change.
Procure seeds needed for later experiments with plants.
Start cuttings of houseplants for the science room.
Begin a weather record.
Collect caterpillars, feed them, and watch them spin cocoons.
Put cocoon in sheltered and protected place out of doors until spring.

October

Collect acorns, horsechestnuts and nuts. Store them in a moist, cool spot for germination studies.
Make studies of first and second year plants of common biennials.
Identify common weeds before the plants die.
Procure plant bulbs for indoor forcing.
Set up aquariums and terrariums for fish, amphibians and reptiles to be kept through the winter.
Make studies of autumn constellations.

November

Collect supplies of sawdust, sand, garden soil and woods soil for use in winter months.
Bury pots of early tulip and hyacinth bulbs for winter forcing.
Start "winter-garden" in terrariums.
Procure sprouting sweet potatoes, set them in water and raise them for vines.
Locate places where erosion is evident, as on newly cut banks, and make drawings or photographs for comparison with conditions in spring.
Begin a series of weekly temperature readings in a stream or pond.
Store beets, carrots and the like in a cool, moist cellar so that sprouting in the spring may be studied.

December

Start forcing paper narcissus for Christmas bloom.
Make bird feeding stations for use in January.
Collect abandoned bird nests.
Collect dead weed tops for study and for winter decoration.
Check shadow stick as near the winter solstice as possible.
Make arrangements for the care of plants and animals over vacation. Often pupils will take them home.
Look for cocoons of moths of the silk-worm group. Store them in a protected place out-of-doors until spring.
Collect insect galls.

January

Put up bird feeding stations.
Order seed catalogs.
Study winter constellations.
Build an incubator for hatching eggs.
Take temperature in air, under snow, deep in the ground, and in the water in streams and ponds.
Begin bird lists.

February

Dig up some pots of bulbs and force them into bloom.
Cut twigs of woody plants and force them into leaf and bloom.
Tap a maple tree and boil down the sap.
Obtain fertilized eggs and start the incubator.
Make seed flats.

March

Make bird houses.
Note shadows on the day of the spring equinox.
Force more bulbs into bloom.
If a south window is available break the dormant period of cacti and other succulents with moisture and sunshine to force them into bloom.
Plant seeds for germination studies.
Bring in stored nuts, and acorns to force them to germinate.

April

Set up bird houses.
Build demonstration bee hive.
Bring in cocoons for study of emergence.
Make records of signs of spring.
Collect frog and toad eggs.
Bring samples of garden soil indoors and watch weed seeds germinate.
Compare flowers and leaves of woody plants out-doors with those of the twigs brought in.

May

Stock demonstration beehive.
Study spring constellations.

June

Make up lists of supplies and equipment needed for replacements.
Note shadow of shadow stick as near the summer solstice as possible.

Gasoline tank cap for automobiles, designed to fit all models, requires no key, is siphon-proof, rust-proof and leak-proof. This gas guard, as it is called, fits into and locks in place when inserted in the tank and becomes permanent. Pressure of the gas pump nozzle opens it for filling.

Rotating red light for airplanes, a safeguard in flight, is a 75-watt lamp of 15,000 beam candlepower mounted under a red plastic dome atop the vertical stabilizer. Two revolving reflectors over the lamp cast fan-shaped beams 180 degrees apart in the horizontal plane.

REALISTIC MODELS OF PLASTIC FOR BIOLOGY

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Modern plastics offer an interesting medium for the production of simple and relatively accurate models of many of the common specimens used in teaching elementary biology. Although plastics are not new as modeling materials, many of the techniques involved are decidedly too intricate and complex for most elementary students, and are better adapted to commercial production. Fluid plastic polymers, of which many types are available, often produce surprising and very satisfactory preparations of the embedded type. Polymerization techniques are still somewhat messy and a bit tricky, but the results are often gratifying and have a professional polished appearance with little effort or practice. This method is not satisfactory for microscopic forms, however, and other applications of plastics involving moulding and casting processes must be sought.

Models of clay and plaster have long served the need in biology courses. Numerous commercial models of invertebrate forms and cell types have been produced and are widely used for teaching purposes. They are often too expensive and detailed to be used in most elementary science courses. The elaborate models of many invertebrates and various flowers executed by the famous Bavarian glass-blowers are extremely realistic but are very valuable museum pieces, even less available for laboratory teaching purposes. Some transparent plastic which could be handled and moulded with ease at first and then retain its shape permanently could be used to advantage. Since such plastics are not presently available, another adaptation is suggested here which partially duplicates the natural appearance of transparent glass in depth perception and which can be modeled and moulded to some extent.

Plastics of the lucite and plexiglass type lend themselves well to superficial forming and carving to give the general body shape of many invertebrate types. Choosing a fairly thick piece of plastic, one can saw and file most of the characteristics of simple protozoa, sponges, or coelenterates. Then with sandpaper and buffer the shaping job can be completed in a minimum amount of time and with moderate effort and ability. Edges can be polished glistening smooth with fine wet-sandpaper and a rag or felt wheel buffer. By now a remarkably realistic ameba or paramecium begins to take shape.

The second step involves a carving process known in plastic craftwork as internal carving. Using this method, and working from behind, one can carve deep into the plastic the details of internal structures such as vacuoles, nuclei, food bodies, and other organoids

or inclusions commonly found in microscopic specimens. This technique has been used largely for the production of earrings, pins, paper weights, and even book ends with very realistic flowers, leaves, fruit, and other decorative patterns. It has equally pleasing possibilities in the production of teaching models, plain and colored. The ground surface catches and transmits light in a most startling and life-like manner, exaggerating the illusion of depth and third dimension. One has the impression of viewing an enormous organism, protoplasmic in composition and most realistic in structure.

Carving is done with any of the many types of motor driven hand grinders, using rotary burrs, files, and tapered drills. Details of internal carving techniques can be found in most of the craft books dealing with plastics in the school library. Modern hobby shops can furnish such books as well as plastics, dyes for coloring, and grinders.

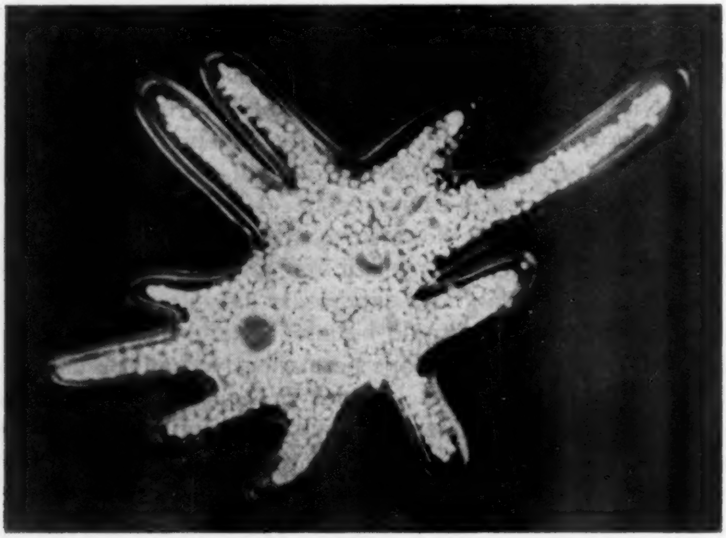

FIG. 1. Model of a protozoa.

A final step may be used to complete the illusion and add somewhat to the detail. Since many of these plastics are softened by heat, submersion of the polished model in boiling water will allow considerable bending and shaping of ameboid pseudopodia or hydroid tentacles. One can work in boiling water with rubber gloves. Using cotton gloves, turned flannel side out, one can work in the heat of a gas or electric oven at temperatures somewhat higher than boiling water for greater flexibility of the plastic. Simply cooling in cold water fixes the shape permanently, after which the model may be dried and handled freely.

The nylon bristles of an old toothbrush may be set in small holes around the edges of a paramecium model with Duco cement to resemble cilia. In other models, bits of sheet plastic or tubing may be cemented together to represent stalks, tentacles, pseudopodia, or other details peculiar to certain forms. Frequent and rough handling of plastic models may require repeated polishing, but if well-planned and fabricated they are essentially unbreakable and easily repaired.

Various internal structures can be readily colored by applying plastic type paints (airplane dope, Duco, plastic enamels) in the carved outlines. In most cases it might be more desirable to restrict coloring to natural tints or pigments. Bright green plastids, crimson eye spots, and other colorful food organisms might naturally be found in some specimens like Euglena or in the food vacuoles of paramecium. Since nuclei are more often obscure and contractile

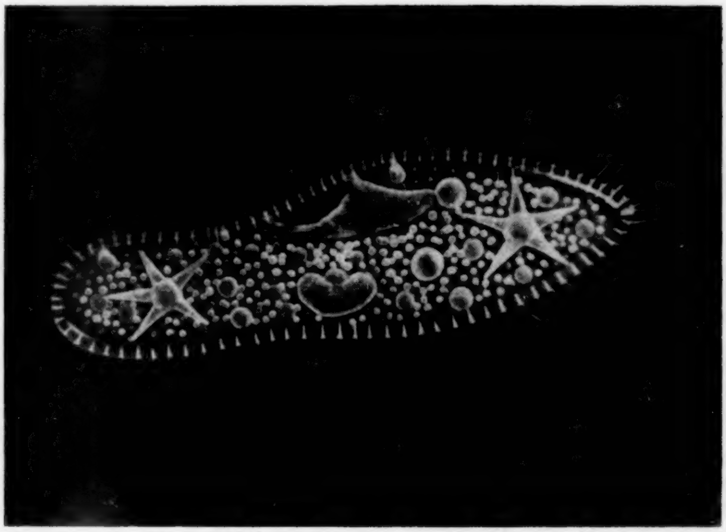

FIG. 2. A paramecium model.

vacuoles are water-clear, it seems better practice to allow these structures to blend subtly into the protoplasm of which they are a part. Such models will also give students a more accurate concept of what they will find under the microscope lens.

This type of model is readily adaptable to the representation of typical or generalized cell structures (plant and animal types), cell tissue types, organ units (villus, alveolus, nephron), as well as various small invertebrates (rotifers, hydra, sponges). Some of these are satisfactory as plaque type models, carved in outline on convenient sized sheets of plastic and displayed over black backgrounds so they

catch light through their edges. Using a picture diagram one can trace the outlines on the upper surface of the plastic. Both surfaces or several layers may be used for depth effects. Various adaptations will readily suggest themselves. The method can be adapted to special projects at all grade levels from elementary science to college courses. Interesting gifts as well as useful teaching models can be produced in quantity by interested students with moderate ability.

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THE HELL-DIVER

The U. S. Biological Survey lists the grebe as a friend of the fishes, because it eats the giant water-bug and a number of other predaceous little monsters of the shallow waters, that prey upon infant fish, and make the hatcheries worker's life a burden. Investigation of the digestive systems of these birds has disclosed the remains of scores and hundreds of these ravenous winged dragons of the lesser world.

But even aside from usefulness to us, the grebe is an interesting bird on its own account. Wary and easily alarmed, it disappears in a split second, leaving scarcely a ripple to show where it has been. And if you can guess where it is coming up, you are better than any hawk or hunter. To all appearances, it often stays under water for half an hour on end. But it really is not making a submarine voyage to a place where water is reputed to be very scarce; if you watch carefully, you will see on the surface of the water a tiny ripple. That is made by the tip of the grebe's nose. The bird is still with us, breathing the familiar air, but is using the better part of valor and taking advantage of the best garment of invisibility known. Presently, if you don't shoot or throw stones, the bird will stick its head and part of its neck up for a periscopic look around; then, if the situation is satisfactory, up will come the dusty back and wings.

The hell-diver spends its time so little in the air and so much in the water that it has given up almost all of that very important flying organ, its tail. But its twin propellers, its feet, are ideally adapted for work in the water. Instead of being fully webbed, as a duck's are, it has a separate web for each toe. This makes its feet "feather" more easily than those of a duck, and also permits it to have longer toes with freer movement.

These large feet act more or less like snowshoes when the bird goes ashore on soft mud, which it frequently does. It seems to like this kind of terrain and builds its semi-floating nest of reeds on the oozy margin of its stream or pond. This habit has earned the grebe is other nickname of mudhen. It is one of the most widely distributed of American birds. It is found all over both North and South America, excepting only the very extremities of the continents.

Spray nozzle, which can be used with the ordinary garden hose to fight fires inside a building, gives a fog that will instantly blanket and extinguish oil, textile and wood fires. The same fog nozzle can be used for spraying lubricants and other solutions.

FIELD WORK MODIFIES OUR PROGRAM IN ARITHMETIC

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This report on field work, extension as we call it in Iowa, is based on visits paid during the past year to schools of all sizes in our state. In no sense is this to be a statistical report of hours spent, teachers visited, or children examined. Many of the conditions noted are of local character, and none are true of all schools.

Iowa State Teachers College offers consultative service to the public schools of the state. This service is rendered by regular members of college departments who are loaned to the director of extension for a quarter at a time. He apportions the time of these people among the schools that ask for workers in the various fields. My field of effort is elementary arithmetic.

The time a worker spends in a place varies from one day, to a week or more, depending on the size of the system and the type of work attempted. My work this present quarter has been conducted according to the following patterns:

Visiting classroom teachers, demonstrating for them, and holding informal conferences with them.

Meeting with arithmetic committees and with groups of elementary principals and supervisors.

Appearing as speaker or resources person at county workshops for rural teachers.

Working with rural supervisors in visiting rural schools to work with individual children.

Much of my time has been spent in demonstration teaching. This seems to be the quickest and surest way to put teachers in a frame of mind to ask questions and get down to cases. It is easier to show, than it is to tell, how to develop certain understandings, and the first hand acquaintance with the children helps in appraising the local situation at the time, as well as serving to build up a stock of experience which helps one to anticipate the needs of other teachers.

We have many elementary teachers with less than two years of college training. We are not boasting of that fact, and the situation is being improved. However, not all the poor teaching is being done by teachers with limited training. An account of the common faults in the everyday practice in our classrooms makes a dismal report, and will serve no good purpose before this group, unless we become "re-examinationist," to borrow a current political epithet, and search ourselves as teachers while I recount some of my impressions.

As I attempt to do demonstrations before the children in our middle and upper elementary grades, I am impressed by the enthusiasm these children express when some supposedly simple idea, which they already possess according to our verbal standards, has been made plain to them by discussion or by concrete demonstration. I have in mind particularly the idea of tens and place value as used in our notation. Many fourth grade children can work subtraction examples using three and four place numbers. But they resort to hesitant and purposeless manipulations when confronted with such a simple example as: taking twenty-seven from forty-five if the forty-five is set up as a real problem with ten blocks. If allowed to work such an example on the board first, they regain some confidence, but many are still unable to point out in detail the correspondence between the symbolic record and what they actually do with the blocks. May not this unbridged chasm between manipulation of numbers and physical reality be one of the main sources of difficulty in problem solving? Of course, the children's confusion might be expected in the light of the limited efforts that are made to tie the use of the symbols to reality. Concrete materials and teaching aids are not widely used in arithmetic teaching.

Children seem not to be accustomed to drawing diagrams to illustrate problem situations, or to trying to prove to each other the rightness of their results. Little attempt is made at generalizing, or at trying to see what would happen in another situation, or if the same thing were done in a different way.

Children seem not to be accustomed to being asked questions beyond the obvious, or to asking such questions themselves. They are startled and very ill at ease as soon as "why" is mentioned, but they appreciate the answers and begin to ask questions once they discover that there really are reasons back of the things we do.

Children seem not to be accustomed to seeing or handling weights, measures, and instruments for measuring. Only last week a superior eighth grade girl was having trouble with the metric equivalents. She couldn't decide whether to multiply or divide in changing pounds to grams. I asked her if she had ever seen or lifted a gram or kilogram weight. She could not remember having seen even the picture of them, and as a consequence, was very hazy about whether a gram was more than a pound, or less. Children *are* accustomed to authoritarianism. "The teacher or the book says so," is the commonest reason given for the hope that is in them.

Children are too little accustomed to real problems. Very few have experience with problems of real consequence from home or from school projects. When it is time for arithmetic, they expect only to manipulate numbers—do something with a pencil.

It is not always the dull student who has trouble interpreting his symbols. Not long ago, a sixth grade girl was highly recommended to me by her teacher. I was asked to give suggestions for helping the child work ahead independently. Casual conversation and a few examples on the blackboard disclosed that she was both accurate and rapid in calculation. She worked a long division problem very rapidly, and set up the remainder as a fraction reduced to lowest terms. She was eager to show her ability, so I asked her if she would try this problem: How many trips must a farmer make in hauling his corn to the elevator, if he has 1250 bushels to sell, and his truck will haul 150 bushels at a load? Her answer, $8\frac{1}{3}$, came with no hesitation. I tried cautiously to get her to reconsider. She multiplied quotient by divisor, and stood pat on her answer. Not until confronted with a sketch of her solution which showed the farmer stranded along the road with part of a load in his truck, did she see that it was her thinking, and not her computing, that was at fault.

Visits with classroom teachers in small groups, after I have done the work, and they feel free to talk, reveal some of the reasons for the children's responses. Many teachers are, of course, content to teach arithmetic as it was taught to them. Too often, all the arithmetic they know is that which they learned in elementary school. They are afraid to experiment with numbers or to introduce any variation from the pattern in the textbook. They object to trying for what meanings they do recognize as demonstrable because of the time it takes to handle, draw, measure, and question. Thorough questioning, rather than telling outright, looks like a waste of time to them. They appear not to accept the idea that learning is evidenced by the response of the child, and is not measured by pages covered or words spoken. Children are not given time to think for fear something untoward will happen. They must be continually computing to occupy time, so the better they work, the more they must be given to do. Even third graders catch on to that before very long!

Teachers fail to act as though they believe that there is a range of ability representing certainly three, and usually five, grade levels in a class of any size. There is sincere doubt in the minds of some as to whether the use of a fourth or fifth grade book is justified for a child who happens to be sitting in a room marked grade six. Recently, a rural teacher reported apologetically, that being at her wit's end with a badly retarded boy, she had resorted to such a degenerate procedure. It seemed to be just the thing except for the fuss caused in the neighborhood when the parents discovered it. I used to use a story about a superintendent who excused the poor showing made by his school with the complaint that almost half his pupils had I.Q.s below 100. The story is too subtle, or else people just don't believe

what we think they believe about the distribution of ability.

There is much preoccupation with the preparation for standardized tests, and a quest for quick results. There seems to be meager knowledge about learning and forgetting. Any trick that produces a quick answer is sought after, regardless of how short lived the recall may be.

Four members of our department have had extension assignments within the past year. Needless to say, this close touch with the classroom has some effect upon us. Our present course offerings have been influenced by the experiences of the staff in the past, and the emphasis we are now giving to the contents of our courses in arithmetic is determined, to a large extent, by our accumulated experience.

All elementary teachers in training at the campus get a course in arithmetic. The major emphasis is on why and how. No premium is placed on computational skill. That varies widely, and will continue to do so in spite of us, although we do offer extra help for those who need it badly. As noted before, teachers teach much as they were taught. This is probably our best opportunity to break the vicious circle. If we teach a lecture and textbook course, reading about and talking about, but never really doing any of the things that can be done to put meaning into arithmetic, we can expect these teachers to do pretty much the same as has been done in the past. Shop facilities are provided in our department, and everyone is expected to make at least a start on devising and collecting concrete teaching aids. The mere possession of them is not enough. Some facility in the use of, and a knowledge of the limitations in the use of such things as ten blocks, abacus, pocket charts, and fraction boards, is expected.

We are not justified in dismissing as the sole concern of the department of education such things as philosophy of teaching and the psychology of learning. Saying the right words about individual differences and child growth is often a way of getting good grades in college, but treating the various small groups in an arithmetic class as though they really were different, is a behavior test of whether the words mean anything or not.

Grouping within classes appears to be just as necessary in arithmetic as in reading. Many of our middle grade disabilities in arithmetic appear to stem from early attempts to teach too much and too fast, and to keep the slow child up with the average, and both in hot pursuit of the superior. How many of us fully accept the doctrine that good teaching is bound to widen, rather than narrow, the range of ability in a class as it goes through the year or through school? If you think you do, then consider: have you complained recently about the lack of homogeneity in any of your classes? Or have you com-

plained that some of your pupils finish their work almost immediately while others can't do it at all? Perhaps we should make up an inventory, and list along with our beliefs about the individual, some of the other things about which we should examine ourselves.

Do we really believe, and act as though we believed in teaching for understanding, to the extent that it really influences our behavior? Do we act as though we believed in rationalization before drill? What about long division on that score? Should we define a few of the most fundamental areas of understanding more closely and concentrate our efforts on them? Place value is certainly one such fundamental area. What should we be sure to teach about it, and at what levels should it be done? Are we alert for opportunities to tie new ideas in with previous experiences, and to create new experiences which bind our abstract thinking to reality? Children seem to be poor at making comparisons and in judging size, distance, value, etc., one of our most frequent uses of arithmetical thinking by the way. Yet, how much help are we giving them toward growth in this use if we don't show them, or even show them pictures of, common measures and units used in comparisons. Possibly we need tests for some of these areas of understanding. Teachers seem to try to teach that which they know will be tested.

I have dealt with some of the questions which come up in dealing with teachers and prospective teachers who have a relatively low level of training. Certainly, we need also more and better supervisors, supervisors who are able to help teachers teach better; not plan book and time schedule inspectors. I hope these problems of meaning in teaching are not so acute at higher levels in our system of teacher training. However, in my graduate school days a knowledge that these problems existed did not make the zealot of me that facing them everyday in a different place is beginning to do. I am beginning to see how some so-called "typical" college professors got that way.

TO MATCH COLORS, DON'T LIE DOWN ON JOB

When you are matching colors do not lie down on the job. The way you see colors is affected by the position of your body, Dr. J. N. Aldington of the Lamp Research Laboratories, Siemens Electric Lamps and Supplies, Ltd., at Preston, reported in a communication to the British science journal *Nature*.

Standing upright on your feet, both your eyes see colors in about the same way. This is usually your posture when you are trying to match the color in a sample. And when you are lying down on your back the color vision of both eyes is alike, also. But if you roll over on one side, the lower eye is more sensitive to red than is the one on top, Dr. Aldington reports. The upper eye is more sensitive to blue. If you turn over on the other side, the color sensitivities of the two eyes are reversed.

A CHEMISTRY CARD GAME

LOUIS PANUSH
Central High School, Detroit, Michigan

The article by Charles Brauer, "A New Aid to Teaching Valence," in the May 1951 issue of this Journal sent this author back to his files to look for the *"Chemistry" Card Game* which one of his students helped in designing and printing way back in 1937 or 1938. The original idea occurred to Mr. James Van Vliet, now an instructor at the Lawrence Institute of Technology in Detroit, after he had read an item in a 1933 issue of the *Science Leaflet* about a science club playing a card game in chemistry which helped the students in learning valences and formulas. Mr. Van Vliet constructed a pasteboard set of cards, representing a number of common elements; on each card he lettered in the symbol and the atomic weight of the element. The game was first tried out with six Science Club students at our high school in 1937. One student, Julian Lee Kavanau, helped the author in redesigning and perfecting the cards and he himself printed 100 sets of "Chemistry" on the presses of the intermediate school which he had attended previously.

The *"Chemistry" Card Game* consists of seventy-two cards. Fifty-six are printed with the name of the element, its symbol, atomic number, and atomic weight. Four cards are marked "Reaction." Twenty-two cards are marked with the numbers 2 through 8, to be used for subscripts in the formula or in balancing an equation. A formula is built by obtaining the necessary cards to express the whole formula. For example, five cards (one each of H, 2, S, O, and 4) will give the formula H_2SO_4. Parentheses are to be understood when needed, but cards must be held for all subscripts except 1 and 0.

The following rules were suggested for playing the *Chemistry Card Game:*

1. Seven cards are dealt to each player, the balance being placed in the center of the table to be drawn during the game.

2. A player in turn draws a card from the center pack and discards one from his hand face up in the center; or he *may* pick up *any one* of the discarded cards instead of drawing.

3. A player lays down for *scoring credit* any complete formula which he builds from cards held and drawn. Example: K_2CO_3.

4. A player may "steal" a formula from another, providing he can make a new formula by adding other cards from his hand. In the new formula he must use *all* the cards in the stolen one. For example: If SO_2 is exposed, a player may "steal" it if he has in his hand an H, 2 and 3, in order to form H_2SO_3.

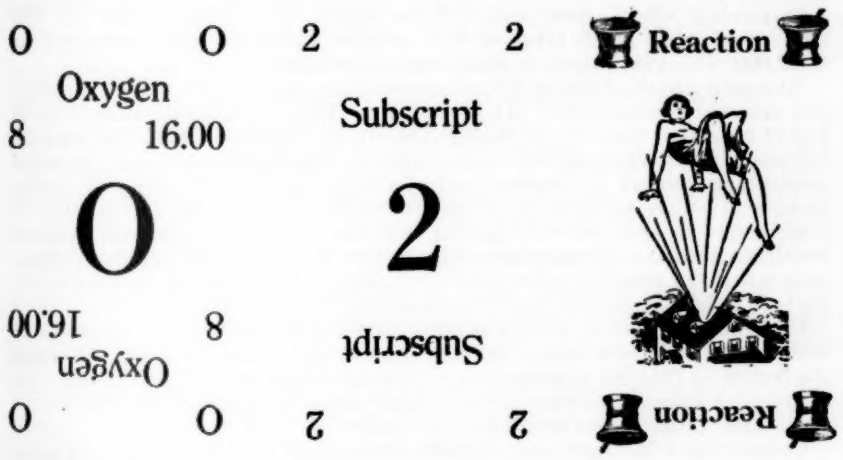
5. A player obtaining a "reaction" card may take any two or more exposed formulae that enter into one reaction and get credit for the reaction products. Such formulae taken are covered with the "reaction" card and are out of use in that deal.

6. A player must be able to *name* any compound for which he wants credit (or the reaction products) on demand of another player.

7. A player "goes out" by using all the cards in his hand to make formulae, thus ending the deal.

The method of scoring was suggested as follows:

1. Values of formulae are determined as follows: For *binary* compounds exposed, credit is given for the *molecular weight* of the compound. Thus, H_2O—18 points; AgCl—143 points. For *tertiary* compounds exposed, *twice the molecular weight*. Thus, H_2SO_4 equals



2×98 or 196 points. For more complicated compounds, a comparable scale, 3 or 4 times the molecular weight, may be set up.

2. The player "going out" gets credit for all his formulae plus a bonus of 100 points.

3. Other players get credit for their formulae *less* the sum of the *atomic numbers* of the elements retained in the hand. If a player retains any *complete* formula (either for preventing stealing or because he did not recognize the formula), a deduction of twice the value of said formula is made.

4. Any player discovering an error by another is credited with the correct formula, instead of the one making the error.

These playing and scoring rules are subject to change and modification in order to make the game more interesting or more difficult for more experienced players.

This *"Chemistry" Card Game* was found to be interesting and stimulating when played at Science Club meetings or by chemistry students at home at their leisure time. It is not recommended by the author for teaching or practice of formulae in the classroom.

THE NATION'S SCHOOLS

"More than one fifth of the Nation's total population will be enrolled in public and private schools and colleges throughout the United States during the 1951–52 academic year," Oscar R. Ewing, Federal Security Administrator, said as he released the annual enrollment estimates prepared by the Office of Education, Federal Security Agency.

Mr. Ewing said, "The Office of Education's advance estimates point to the highest enrollment ever recorded—33,121,000, which surpasses even the 1950–51 peak of 32,703,000.

"The most substantial enrollment rise will be at the elementary school level. Last year's elementary school enrollment was 23,686,000. This year's estimate is 24,468,000.

"Secondary school enrollments will rise slightly over those of 1950–51. The number of pupils in all types of high schools during the past year stood at 6,142,000. This year's figure is estimated at 6,168,000.

"According to the Office of Education estimates there will be a drop in college and university enrollments," Mr. Ewing said. "There were 2,500,000 students in higher education institutions during 1950–51. It is expected that this number will probably drop to 2,225,000 during 1951–52. The decrease will result from the diminishing number of veterans and also from the drafting of a substantial number of college-age men. It should be noted, however, that during 1951–52 many reservists and draftees returning to civilian life may be expected to enroll for higher education. Furthermore, if legislation now before the Congress authorizing a new G-I educational program for Korean veterans should be passed, the 1951–52 college enrollment figure would show a marked increase."

Earl James McGrath, U. S. Commissioner of Education, today warned that with three-fourths of a million additional children in elementary schools across the Nation in 1951–52, communities will be challenged more than ever this year to provide a sufficient number of teachers and school buildings to insure adequate educational programs for their boys and girls.

Commissioner McGrath said, "99,000 new teachers will be needed to fill positions left vacant by retirement, resignation, or death during 1951–52. Additional numbers of children enrolled will require 21,600 teachers who did not teach last year. Of the 120,600 total, elementary schools will need 87,000 new teachers, high schools, 33,000. Although the supply of high school teachers will be found adequate in most communities, there will be a scarcity of elementary school teachers who have standard training.

"For long-range school construction planning, the Office of Education is making a national survey of school building needs," Commissioner McGrath said. "At this time, however, we know that we must provide classrooms for children who are enrolled, that we should plan educational facilities for the children of peak birth-rate years coming along, and that we should guarantee safe and healthful school environment for children wherever they may live.

"To keep pace with the increasing number of children, which, by 1959–60, will swell public and private elementary and secondary school enrollments by 6,500,000 to a high of 37,138,000, approximately a half million more classrooms than we now have will be needed. Expanded school enrollments in 1951–52 will call for 25,000 new classrooms. To replace obsolete facilities, an additional 18,000 classrooms should be provided. One of every five schoolhouses now in use throughout the United States should be abandoned or extensively remodeled because they are fire hazards, obsolete, or health risks," Commissioner McGrath said.

COAL THROUGH THE MICROSCOPE*

G. K. Guennel
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Man has looked to the microscope with ever-increasing confidence for comprehension and understanding of the smaller and smaller units that constitute plants, animals, and the inorganic world. The microscope has given us a better understanding of the structure and function of matter as well as of the larger biological forms. In the study of micro-organisms, the microscope has played a vital part in the conquest of diseases which but a few decades ago decimated human populations. Every field of science today leans heavily on the microscope for knowledge of the things with which it works. From the university laboratories this marvelous instrument moved into the classrooms of our schools where it daily performs its miraculous deeds of disclosing unknown wonders to the searching eyes of our college and high school students. It is even found in elementary schools, and as a plaything has taken its place with the doll, scooter, and picture book beneath the Christmas tree.

During the past century the microscope also invaded paleontology, the science concerned with life of the past. Minute animal and plant remains found preserved in rocks and other sediments have been studied under the all-revealing eye of the microscope. Information on mighty forest migrations which took place near the borders of continental ice sheets has been disclosed through microscopic examination of pollen dusts that were deposited in lakes, lagoons, and other bodies of water. In retracing the appearance, dominance, and extinction of these post-glacial forests, the climatic conditions which determined their birth and death can be deduced.

One of the most recent invasions by the microscope has been the coal and oil industry. Although the Greeks, and even the Chinese before them, recognized the burning qualities of certain rocks, coal was not mined extensively until the advent of the steam engine. The coal-bearing strata have long been known as "Coal Measures." In time they were differentiated into Upper Carboniferous; and the barren groups below, as the Lower Carboniferous. In America geologists generally regard the two groups as separate systems and term them Pennsylvanian and Mississippian, younger and older, respectively. The Pennsylvanian System consists of rock layers which contain a fairly large number of coal seams of different thicknesses. The rocks between the coal beds are limestone, shale, and sandstone, all

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Note: This paper was written by special request of the editor. J.E.P.

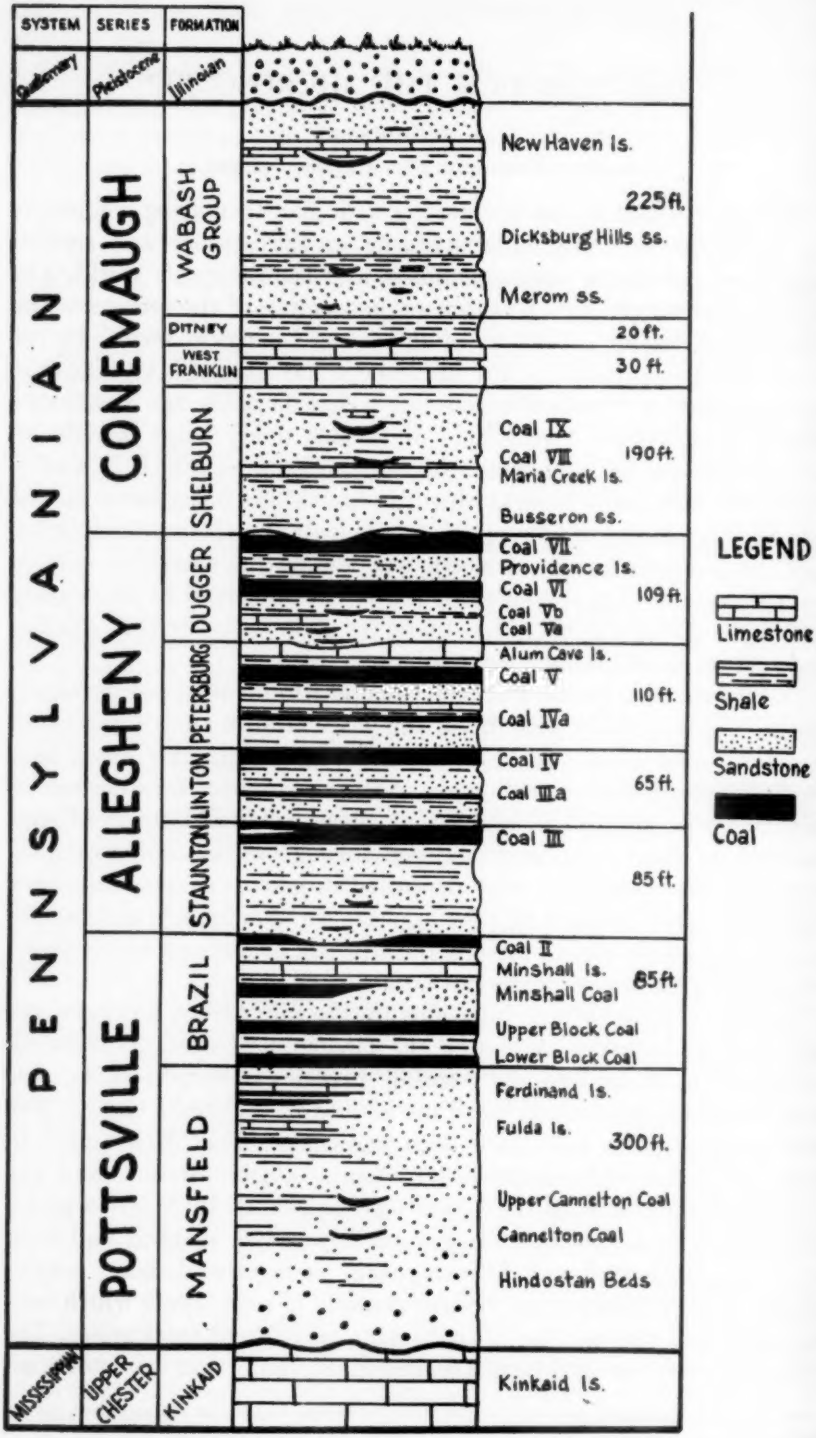

FIG. 1. Composite stratigraphic column of coal-bearing rocks in Indiana. (After C. E. Wier.)

of which are sedimentary. In Indiana the Pennsylvanian System is divided into three major divisions that geologists call the Pottsville, Allegheny, and Conemaugh. Most of the commercially mined coals are in the Alleghenian Series. A diagrammatic vertical column through the coal-bearing strata of Indiana is given in Figure 1.

Since most of our easily accessible coal has been mined, government and industry are vitally interested in obtaining accurate scientific information regarding the nature and extent of our coal seams. Studies of coal, its location, mineability, and industrial value are being conducted in many places, among them the Coal Section of the Indiana Geological Survey.

The study of coal is much more complex than simply discovering the coal and mining it. The geologist must construct overall maps of the coal beds from information that he obtains studying outcrops of the coals and interbedded rocks and from drilling information which usually is scattered and often incorrect. Pressure, erosion, glaciation, and faults sometimes pushed out of place or broke up coal beds that were originally in the flat position in which they were deposited. Thus frequently a particular seam is mistaken for an entirely different coal.

Since coal is of plant origin, a major part of research on coal must be done by the botanist and his microscope. Two methods are used to prepare coal for study: thin-sectioning and chemical maceration. In thin-sectioning, more or less reserved for the geologist in petrographic research, a piece of coal is ground and polished until it becomes translucent. Special cutting and polishing machines are necessary for good results. This super-thin wafer of coal is then mounted on a glass slide for observation under the microscope. Figure 2 is a photomicrograph of a portion of such a thin section and shows that coal is not a homogeneous substance, but is layered and greatly diverse in its composition. The long and thin white streak above the center represents a longitudinal section through a megaspore, or female spore, and the smaller white streaks represent similar sections of microspores, or male spores. Spore analysis is a recently developed and accurate method of determining the origin, age; and correlation of a coal bed. This type of microscopic research is being done at Indiana University in the Geological Survey Coal Laboratory.

The coal samples are obtained wherever the coal seam is exposed, in a mine, outcrop, or even from material brought to the surface by diamond drilling. Chips of coal are broken off perpendicular to the plane of deposition, sacked and labeled. Usually several "benches" or layers make up a seam. Each bench is treated separately, since a thin "parting" of shale at one locality may be a 10-foot shale bed at another, and thus thought to be two distinct coal seams. In some

Fig. 2

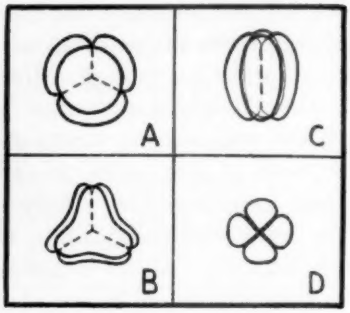

Fig. 4

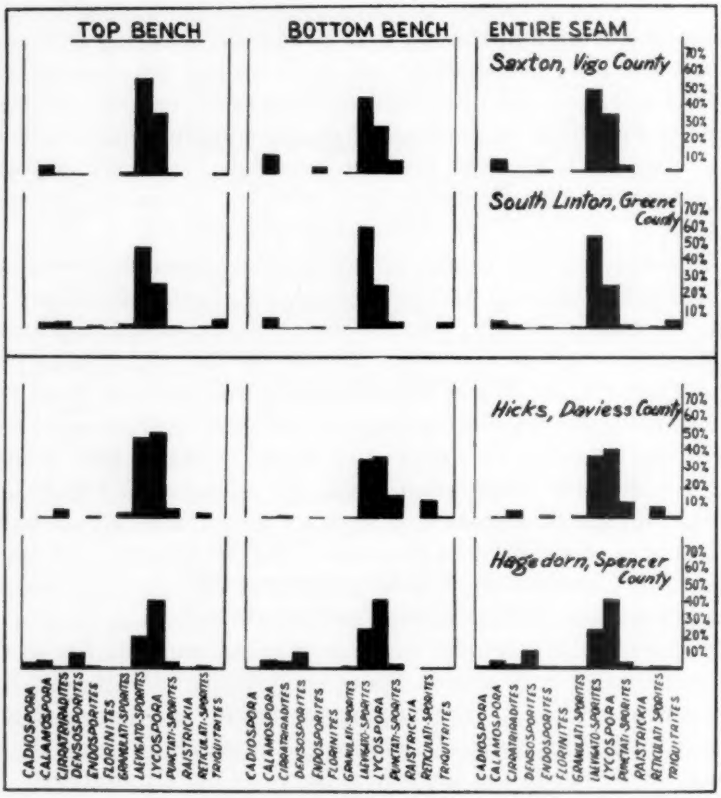

Fig. 3

FIG. 2. Photomicrograph of thin section of Coal III, Coalmont, Indiana. Woody tissue and flattened spores are visible.

FIG. 4. Diagrams of tetrads. A and B, radially symmetrical spores; C and D, side and sectional views respectively of bilateral spores.

FIG. 3. Percentage relationship graphs of coal samples from four Indiana mines. Graphs at right are composites of bench graphs shown on left. Fossil spore genera are listed at the bottom.

seams the various benches can be differentiated on the basis of spore contents. In the laboratory the coal sample is ground up and immersed in a solution of nitric acid and potassium chlorate, known as Schultze's reagent, after the German scientist who discovered the maceration method. The resultant chemical reaction partly oxidizes the coal and releases humic acids, After several days in the solution, the sample is washed thoroughly and treated with a 10 per cent solution of potassium hydroxide. Again a thorough washing follows, and the material is sized by passing it through a 70-mesh screen. The material that will not pass through the screen contains macrofragments, including megaspores, and the minus 70 residue contains a concentration of small spores and other minute plant ingredients. This fine material is stained with a biological dye to facilitate identification, dehydrated with alcohol, and mounted on slides. The "coal" is now ready for examination under the microscope.

The tree ferns, scale trees, and giant horsetails which made up the vast forests of the "Coal Age" shed great quantities of spores. Due to the resinous and waxy outer coatings of spores, these microscopic fossils have been preserved 200 million years or more and are valuable tools of the paleobotanist in his attempt to learn about life of the far-distant past. Two types of vascular plants produce spores. One type, the homosporous plants, produces but a single kind of spore, the homospore. The other type, the heterosporous, gives rise to two genetically different kinds of spores, called microspores and megaspores. The microspores are male and very small, whereas megaspores are female and large. (See Figure 2.) The homospores and microspores range from about 1/2500 to 3/250 of an inch in size. Because of their small size and great number, the microspores and homospores of the "Coal Age" plants were wind-carried and dispersed over wider areas than the larger and heavier megaspores and are therefore of great value to the paleobotanist.

By studying these fossil spores, millions of years after they were produced and disseminated, the botanist is able to reconstruct some of the prehistoric past and can contribute considerably to the store of scientific knowledge. An immediate and thoroughly practical application, also, is possible in the coal and oil industry by using the spores as horizon markers.

Because of the long intervals of time between the deposition of plant debris, i.e. decaying swamp forests, and intermittent flooding by ocean waters for long periods of time, each coal seam is marked by a distinct flora.

Spores shed by the plants which now comprise a given seam reflect the relative abundances of the plants themselves. In addition to ecological factors revealed, evolutionary tendencies are recorded.

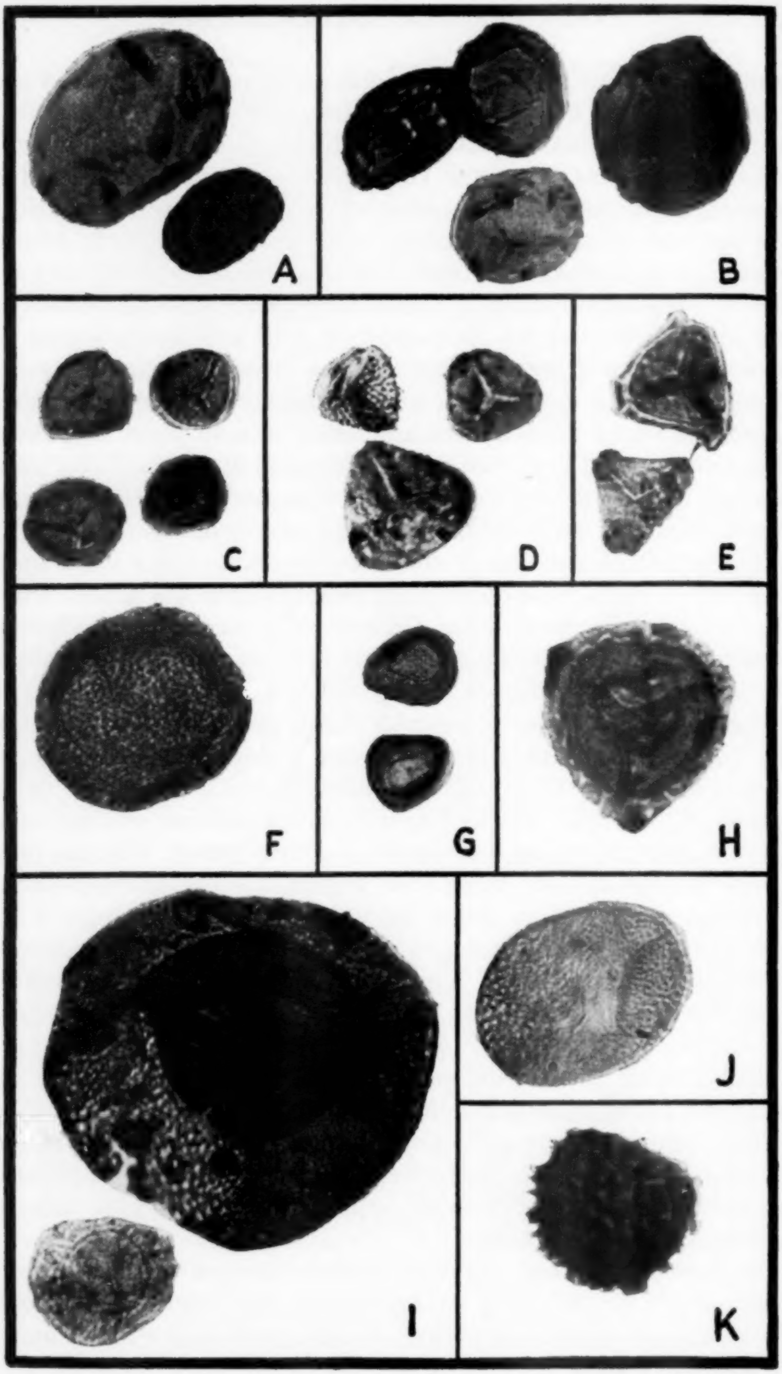

FIG. 5. Photomicrographs of spores found in Indiana coal veins. Magnified about 365 times. A, *Laevigato-sporites*; B, *Calamospora*; C, *Lycospora*; D, *Granulati-sporites*; E, *Triquitrites*; F, *Punctati-sporites*; G, *Densosporites*; H, *Cirratriradites*; I, *Endosporites*; J, *Florinites*; and K, *Raistrickia*.

Thus can be traced the birth, maturity, decline, and finally extinction of species of prehistoric plant giants. Relative abundance of species can be expressed in percentages. Birth and death dates of species are determinable if the species have been traced through layer after layer of coal. The presence or absence of a certain type of spore then becomes indicative of a certain horizon, i.e. age of the coal. A slightly less refined method, but much less time-consuming, is the use of statistics based on relative abundances of genera. The percentage relationships of genera differ with each coal seam. Once these relationships are determined for known coal seams, the spore analyst need merely compare the figures derived for an unknown coal to those established standards in order to place the unknown seam in its age horizon.

Figure 3 shows graphs of percentage relationships of spore genera for Coal IV. The graphs in the upper two rows are of samples gathered from the Saxton and South Linton shaft mines. A striking similarity is evident. Geologists thought the same coal bed is present in the two mines. The spore investigations proved the geologists correct. The coal represented by the bottom rows of graphs was thought to be the same as that mined at the other two localities. The different patterns in the bottom graphs obviously are not the same as the upper two rows and, therefore, are not from the same bed of coal but represent two additional coal beds.

Although spores are extremely minute, they show great variety in shape, size, and ornamentation. Most spores are marked by a dehiscence scar. This mark is the result of the spore's former attachment to three other spores during the tetrad stage of spore development. As Figure 4, A and B, shows, each spore in the tetrad cluster is attached to the other three. If the attachment is along more than one contiguous surface, the scars will show branching, if along one surface only, the spores tend to be bilateral in shape and thus are marked by an unbranched scar. The diagrams C and D of Figure 4 illustrate the latter type of tetrad composition. The spores shown in A, Figure 5, owe their bean-shape to bilateral tetrad orientation. This characteristic differentiates spores of the genus *Laevigato-sporites* from all others.

Calamospora (Figure 5, B) is marked by a small trilete scar and has very thin walls, giving it a membranous appearance. Spores of the genus *Lycospora* (Figure 5, C) are characterized by their relatively small size, 20 to 40 microns, a ridge-like thickening around the equator, and a branched scar which normally extends through the ridge. Spores of the genus *Granulati-sporites* (Figure 5, D) are triangular in shape, with concave or convex sides and usually granular outer coatings. *Triquitrites* (Figure 5, E) is also triangular in shape, but is thick at the corners.

Punctati-sporites (Figure 5, F) usually is spherical and the coat is punctate. *Densosporites* (Figure 5, G) is distinguished from all other genera by a differentially thickened, opaque band around the periphery. *Cirratriradites* (Figure 5, H) is characterized by possession of an equatorial flange. *Endosporites* (Figure 5, I) and *Florinites* (Figure 5, J) have bladder-like membranes. *Raistrickia* (Figure 5, K) has finger-like appendages.

The photomicrographs demonstrate how these minute bodies differ in size and shape, how morphological variation serves to differentiate them, and how, on the basis of these criteria, they can be identified and used to correlate coal beds.

The horizons are unlimited. Every bit of information obtained through painstaking microscopic investigation adds another building stone to the knowledge of life of the dim past. Through interpretation of such data we can better understand life as it exists today.

CORONARY SUFFERERS LIVE AVERAGE FIVE YEARS

Sufferers from angina pectoris and coronary occlusion, which are serious heart diseases, have on the average the chance of living about five years or more after their first attack, a study of 1,700 cases by Dr. Louis H. Sigler of Brooklyn, N. Y., shows.

A statistical study reported to the *Journal of the American Medical Association* shows that the over-all average age at onset of the illness for the 1,700 persons studied was 55.8 years. The average length of survival of the 679 patients who died was 4.7 years for males and 4.5 years for females. For those who were still living when the study was made, the average age of survival was 5.3 years for males and 5.6 years for females.

One patient lived 35 years after the first attack, and the oldest age at death was 94 years. Over half of the patients lived beyond 60.

CARBON DIOXIDE ATTRACTIVE TO FEMALE MOSQUITOES

The thing that attracts mosquitoes to you may be the carbon dioxide formed in your body and exhaled on your breath.

Studies suggesting this are reported by Dr. W. C. Reeves of the Hooper Foundation for Medical Research and the School of Public Health, University of California.

Dry ice, which is solidified carbon dioxide, was used for the source of the gas in Dr. Reeves' studies. Primary object of the studies was to find good bait for collecting mosquitoes for research of various kinds in connection with the diseases mosquitoes spread.

In 49 trials using dry ice to bait his traps, Dr. Reeves collected 14,277 female mosquitoes of six different species. The dry ice was consistently more attractive than animal bait such as calf or chickens.

Only six male mosquitoes were collected in the dry-ice baited traps, and only three males by the animal baited traps. This, Dr. Reeves suggests, may be further evidence that the attraction of carbon dioxide for mosquitoes is closely allied to search for a source of blood.

STATE REQUIREMENTS FOR CERTIFYING TEACHERS OF HIGH-SCHOOL SCIENCE

George Greisen Mallinson
Western Michigan College of Education, Kalamazoo, Michigan

The establishment of adequate subject-matter requirements for certifying teachers of high-school science has long been a problem in the field of education. The problem has been intensified by the fact that usually elementary teachers are not trained adequately in science. Yet, it would be unfair to place the blame on the elementary teachers.

Two recent studies[1,2] in the training of elementary-school teachers indicate the following:

1. There is little evidence to indicate that critic teachers in the teachers' colleges are sufficiently well-schooled in science to guide their student teachers adequately in teaching science.

2. There is evidence to indicate that the requirements set up by various states for certifying elementary teachers do not include science in proportion to its importance in the educative process. In thirty-two states it is possible for a teacher to be certified to teach in the elementary grades without having taken any courses in science. Further, in forty-three of the forty-eight states it is possible to act as a specialist or consultant in the teaching of elementary science and to supervise the teaching of elementary science without having had any academic credit in science.

Hence, it would seem reasonable to state that the teaching of science is considered, either directly, or tacitly, to be a function of the secondary school. Thus, it would seem reasonable to assume that teachers of science in the secondary school would be trained adequately in science in order to teach a subject receiving small emphasis in the lower grades. However, the latter assumption is not supported by the findings of research.

Pruitt[3] summarized the results of four studies, the major purpose of which was to determine the status of science teaching in the high schools of Oklahoma. Riddle[4] summarized the answers from 3186 responses received to questionnaires sent to teachers of biology throughout the nation. These studies indicated that, in general,

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[1] George Greisen Mallinson, "Preparing Critic Teachers to Supervise and Teach Elementary Science." *Science Education*, XXXII (October 1948), 254–258.

[2] George Greisen Mallinson, "State Requirements for Certification of Teachers of Elementary Science." *Science Education*, XXXIII (October, 1949), 289–291.

[3] Clarence M. Pruitt, "Science Teaching in the High Schools of Oklahoma." *Science Education*, XXVII (December, 1943), 122–125.

[4] Oscar Riddle, *et al.*, *The Teaching of Biology in Secondary Schools of the United States*. The Committee on the Teaching of Biology of the Union of American Biological Societies. Distributed by D. F. Miller, Zoology Department, Ohio State University, Columbus, Ohio, 1942. Published in *The American Biology Teacher*, issues of 1941–1942.

teachers of science in high schools are not as well-trained as might be desirable. Their backgrounds in subject matter tend to be extensive in certain areas of science and meager in others. Further, the studies offer little evidence to indicate that they expend much effort in correcting their deficiencies.

Two recent studies by Mallinson[5,6] provide evidence that substantiates the findings of Pruitt and Riddle. In essence, they indicate that the training of student teachers in science tends to be specialized, and that the student teachers do not seem to possess the knowledge of subject matter sufficient to teach science courses outside their special fields. Further, the emphasis in the training of student teachers in science seems to be placed more upon the learning of factual information than upon the ability to apply scientific principles.

A more recent study[7] provides a limited amount of evidence with respect to the number of semester hours of college science desirable for assuring subject-matter competence in science. The data from this study indicates that many teachers of science have not taken the number of semester hours to assure such competence.

The results from all these investigations raise the following question:

"To what extent are state requirements for certifying teachers of high-school science sufficient, *at the present time*, to assure the subject-matter competence of science teachers?" The question has been one of major concern to the Cooperative Committee on the Teaching of Science and Mathematics of the American Association for the Advancement of Science. Hence, it was decided (1) to determine the requirements in science in all the forty-eight states for certifying teachers of science, and (2) to compare this information with recommendations and evidence found in other reports and investigations.

Methods Employed

Letters were sent to the Directors of Teacher Certification, Departments of Public Instruction of all the forty-eight states. A sample letter follows: (See top of next page)

A second letter was sent two months later to those states that failed to respond to the first one. Within two weeks after sending the second letter, replies had been received from all the forty-eight states. Later, the information concerning the science requirements was abstracted from the letters and publications that were received.

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5 George Greisen Mallinson, "An Investigation of the Subject-Matter Backgrounds of Student Teachers in Science." SCHOOL SCIENCE AND MATHEMATICS, XLIX (April, 1949), 265-272.

6 George Greisen Mallinson, "A Comparison Between the Scores Obtained on A Science Achievement Test by Student Teachers in Science and by High-School Pupils." SCHOOL SCIENCE AND MATHEMATICS, XLIX (December, 1949), 731-736.

7 George Greisen Mallinson and Conway C. Sams, "An Investigation of the Subject-Matter Competence of Student Teachers in Science." SCHOOL SCIENCE AND MATHEMATICS, LI (June, 1951), 461-469.

February 19, 1949

Director of Teacher Certification
Department of Public Instruction
State of Missouri
Jefferson City, Missouri

Dear Sir:

We are at the present time making a survey of certification requirements for teachers of science. In our efforts to develop a science education program in this school we are hoping to learn present practices as prescribed by state departments of education. Specifically, we are desirous of obtaining the following information:

1. What are the specific requirements in science for teaching any or all of the sciences at the secondary-school level?
2. Do you have any specific requirements in science for certifying supervisors or consultants of secondary-school science?

This information will be extremely valuable to us and we sincerely hope that you will be able to help us obtain it for your state. If there are any charges for material or publications, we shall gladly assume the obligation.

We shall sincerely appreciate your efforts.

Very truly yours,
GEORGE G. MALLINSON
Professor of Psychology and Education

A copy of the requirements for each state was sent to the respective director of teacher certification in order to check its accuracy. A copy of this "check letter" follows:

November 9, 1950

Dear

On information was received from you concerning the requirements in science for certifying teachers and supervisors of science in the secondary schools in your state.

A summary of the information received from all the states will be tabulated and the results published. Hence a statement is here given of the requirements of your state as we interpret them:

Certification of Teachers	*Certification of Supervisors or Consultants*

If this is an accurate statement of your state's requirements please "OK" this letter and return it to me. If not, make any desired corrections on the opposite side and return it to me. We wish to be fair and correct with each state.

Your cooperation is appreciated.

Sincerely,
GEORGE G. MALLINSON
Professor of Psychology and Education

Within three weeks, copies of the check letter, corrected as needed, were received from all the states. Table I that follows contains the names of the states, the requirements in science for certifying science teachers in the secondary school, and also supervisors or consultants in science in the secondary school.

TABLE I. SCIENCE REQUIREMENTS FOR CERTIFYING SCIENCE TEACHERS AND SCIENCE SUPERVISORS

State	Science Teachers	Science Supervisors or Consultants
Alabama	(1) All students must take 9 quarter hours of science to satisfy general education requirements for "secondary certificate." (2) Student may teach courses in which he has an "academic major or minor." (a) "Academic major" in science—36 quarter hours. (b) "Academic minor" in science—27 quarter hours. To teach: (3) General science—minimum of 3 quarter hours in each of chemistry, physics and biology.	None
Arizona	May teach in major or minor fields. (a) Major in science—24 semester hours. (b) Minor in science—"not less than 15 semester hours."	None
Arkansas	(1) All students must take 12 semester hours of science to satisfy general education requirements for secondary certificate. (2) To teach: (a) Biology—8 semester hours. (b) Chemistry—8 semester hours. (c) Physics—8 semester hours. (d) General science—16 semester hours (8 in the biological and 8 in the physical sciences.) (3) A "group science" certificate shall include 24 semester hours, including courses in all areas of science. (4) One course for any type of certification must include laboratory work.	None
California	(1) To teach life science and general science—36 semester hours including life science or biology; physics and chemistry or general life science; "and additional preparation in one or more of the life sciences to complete the major." (2) To teach physical science and general science—36 semester hours including physics and chemistry or general physical science; life science or biology; "and additional preparation in one or more of the physical sciences to complete the major."	None

State	Science Teachers	Science Supervisors or Consultants
Colorado	None	None
Connecticut	To teach: (1) Any science subject—15 semester hours in that subject. (2) All physical sciences—15 semester hours in physics and chemistry, but not less than 6 semester hours in each. (3) All biological sciences—15 semester hours in biological sciences.	None
Delaware	(1) To teach all sciences—18 semester hours in science. (2) May teach one class in any science in which 6 semester hours of science are acquired, or two classes in which 12 semester hours of science are acquired.	"Certificate in teaching speciality, plus a master's degree in speciality." Also 3 years of supervision or teaching of subject supervised.
Florida	To teach: (1) All sciences—"36 semester hours of science are required." (2) Any single area—15 semester hours in that area.	None
Georgia	"In order to be certified to teach natural science, 50 quarter hours in biology, chemistry, physics, geography and geology with a minimum of 20 quarter hours in at least one science are required."	None
Idaho	"May teach in major or minor according to specialization in college preparation. A minor shall be interpreted to mean not less than 15 semester hours."	None
Illinois	(1) All students must take 6 semester hours of natural science to satisfy general education requirements for secondary certificate. (2) May teach in major and minor fields: (a) Major in science—32 semester hours. (b) Minor in science—16 semester hours.	None
Indiana	To teach: (1) Biological sciences—40 semester hours with a minimum of 3 semester hours in each of biology, botany, zoology, physiology, health or first aid, safety, conservation and physical science. (This certificate entitles holder to teach general science.) (2) Physical science and mathemat-	60 semester hours in special field to be supervised.

State	Science Teachers	Science Supervisors or Consultants
	ics—40 semester hours in two of physics, chemistry and mathematics. If physics and chemistry are chosen, mathematics should be chosen as a "limited area" in which to teach.	
Iowa	May teach all sciences if 10 semester hours are acquired in sciences, with at least 3 semester hours in each subject taught.	None
Kansas	To teach all sciences a minimum of 24 semester hours of science, with at least 6 semester hours in science field taught.	None
Kentucky	May teach in major or minor fields: (1) If teaching fields are represented by two majors—36 quarter hours in each. (2) If major and two minors—36 quarter hours in major, and 24 quarter hours in each minor. (3) If field of concentration (all sciences)—72 quarter hours in sciences.	None
Louisiana	(1) All students must take 3 semester hours in biological science, 3 semester hours in physical science, and 6 semester (elective) hours in science to satisfy general educational requirements for secondary certificate. (2) To teach science, additional hours as follows: (a) Biology—6 semester hours. (b) Chemistry—6 semester hours. (c) Physics—6 semester hours. or (d) 6 additional hours in any other science field in which teacher applies for certification.	None
Maine	May teach in major or minor fields: (1) Major in science—24 semester hours. (2) Minor in science—15 semester hours.	None
Maryland	(1) 18 semester hours in field of science taught. However, 12 semester hours plus 6 in any other natural sci-science will suffice *if* the field of science taught was studied in high school. (2) 27 semester hours in sciences certify one to teach all sciences. These hours must include 6 in each of biology, chemistry and physics plus 6 additional in any one of them, plus 3 in any other science field.	None

State	Science Teachers	Science Supervisors or Consultants
Massachusetts	None	None
Michigan	"The institution recommending that the candidate be certified, may recommend a group major in science that would legally qualify the holder to teach any science subject at the secondary level. Normally a minor of 15 semester hours in one specific area of science is required."	None
Minnesota	"Can teach if one has major or minor in field of science from an accredited teacher training institution."	Teachers certificate in field of science.
Mississippi	"In order to teach science 36 quarter hours in science are required with a minimum of 12 quarter hours in each science field taught, except for chemistry that requires 18 quarter hours."	None
Missouri	"In order to teach science 24 semester hours in science are required including 15 in each science taught."	None
Montana	May teach in major or minor field. (1) Major in science—45 quarter hours. (2) Minor in science—30 quarter hours.	None
Nebraska	"A teaching minor of 15 semester hours distributed in all fields of science with at least 6 semester hours in each specific science subject taught."	None
Nevada	None	None
New Hampshire	18 semester hours in science, with 6 semester hours in each science subject taught.	Major in field of science.
New Jersey	"Two teaching fields required: (1) Major field—30 semester hours. (2) Minor field—18 semester hours.	24 semester hours in addition to permanent teaching certification of which "some (of the 24 hours) must be additional courses related to the specific subject field."
New Mexico	(1) Must have major or minor (college requirements) in subjects taught. (2) Must have at least 10 semester hours in major or minor with at least 3 semester hours in specific subject taught.	None

State	Science Teachers	Science Supervisors or Consultants
New York	To teach: (1) Biological science—18 semester hours in the field of biology. (2) Physical science—18 semester hours including 6 in chemistry, 6 in physics and 6 elective hours in any physical science. (3) All sciences—"12 semester hours in biological science, 6 semester hours in chemistry, 6 semester hours in physics, and 6 semester hours in electives in any science subject."	None
North Carolina	"To teach all sciences—30 semester hours are required to include: (a) Biology—6 semester hours. (b) Chemistry—6 semester hours. (c) Physics—6 semester hours. (d) Geography or geology—3 semester hours. (e) Electives from a, b, c and/or d—9 semester hours. Individual certification will be granted in any of the specific areas a, b, c or d in which 12 semester hours are presented. Certification to teach general science requires 18 semester hours distributed among at least 3 of the 4 areas in a, b, c and d."	None
North Dakota	"Major or minor (college requirements) or at least 15 semester hours in science taught."	None
Ohio	To teach: (1) Biology—15 semester hours, including 3 in zoology, 3 in botany and 9 in related electives. (2) Earth Science—15 semester hours, including 3 in geology, 3 in geography and 9 in related electives. (3) General Science—15 semester hours, including 3 in physics, 3 in chemistry, 3 in biology and 6 in related electives. (4) Physical Science—15 semester hours, including 6 in chemistry, 6 in physics and 3 in related electives. (5) All sciences—40 semester hours distributed among physics, chemistry, astronomy, zoology, botany and geology.	"Master's degree in subject-matter field supervised."
Oklahoma	To teach: (1) Chemistry, physics or geology—16 semester hours in specific field plus 8 in related science fields.	None

State	Science Teachers	Science Supervisors or Consultants
	(2) Physical Geography—8 semester hours in physical geography plus 16 in related science fields. (3) Biology—6 semester hours in each of zoology and botany, 4 in physiology plus 8 in related science fields. (4) Science, General—4 semester hours in each of chemistry and physics, 6 in biology, 2 in physiology, and 8 in related science fields.	
Oregon	None	None
Pennsylvania	To teach: (1) Biological Science—6 semester hours in each of botany and zoology plus 6 additional in either or in definitely related fields. (2) Physical Science—6 semester hours in each of chemistry and physics plus 6 additional in either or in definitely related fields. (3) General Science—18 semester hours in any or all of the sciences. (4) All sciences—9 semester hours in biological sciences, including 3 in each of botany and zoology, and 9 semester hours in physical sciences, including 3 in each of chemistry and physics.	None
Rhode Island	None	None
South Carolina	All students must take 6 semester hours in each of biological and physical science to satisfy general education requirements for secondary certificate. To teach: (1) All sciences—30 semester hours in sciences including 6 in each of biology, physics and chemistry. 18 semester hours must be in laboratory courses. (2) General Science—18 semester hours required in 3 science fields. 12 semester hours must be in laboratory courses. (3) Individual certification in any science on completion of 12 semester hours.	None
South Dakota	(1) Any one science—15 semester hours in that science. (2) "Combined science—20 semester hours are required in which at least 6 shall be in the science taught. In case of biology, preparation must include at least 3 in each of the fields of zoology, and botany or 6 hours in biology. In	None

State	Science Teachers	Science Supervisors or Consultants
	physical science, at least 3 hours in each of the fields of physics, and chemistry and 6 hours in physical science. These courses must be laboratory courses."	
Tennessee	At least: (1) 27 quarter hours of science are required to teach all sciences. Will be certified in those in which applicant has 9 quarter hours. 9 quarter hours in two fields entitles teacher to teach general science. (2) 18 quarter hours in any of biology, physics and chemistry without regard for credit in others entitles one to certification in that science.	None
Texas	"The only specific requirements that teacher of science must have is a major in science and be assigned to teaching work in the phase of science in which the major part of work was taken."	
Utah	(1) May teach in major or minor field (individual science). (a) Major in science—30 quarter hours. (b) Minor in science—18 quarter hours. (2) Composite science major—60 quarter hours in biological science or in physical science (minimum of 18 quarter hours in three fields under each) entitles individual to teach in any area included in composite major.	None
Vermont	None	None
Virginia	Teachers certified in each science area individually; 12 semester hours are required to be certified in each area, except for general science which requires 18 semester hours to be distributed among the various physical and biological sciences.	Major in field of supervision
Washington	May teach in major or minor field. (a) Major in science—30 quarter hours. (b) Minor in science—15 quarter hours.	None
West Virginia	All students must take 6 semester hours in basic science to satisfy general education requirements for secondary certificate.	None

State	Science Teachers	Science Supervisors or Consultants
	To teach: (1) Biological Science—24 semester hours. (2) Biological and General Science—34 semester hours. (3) Physical Science—24 semester hours. (4) Physical and General Science—34 semester hours. (Specific courses required by state for all of above certificates.)	
Wisconsin	To teach: (1) Any one science—major of 24 semester hours or minor of 15 semester hours. (2) All sciences—45 semester hours distributed among chemistry, physics and biology. (3) General Science—5 semester hours in each of chemistry, physics and biology.	None
Wyoming	"Teach science if a major subject. Major field requires 22½ quarter hours. May not be certified in more than three major subjects."	None

Recommendations for Teacher Certification from Other Reports

In order to obtain evidence with respect to the second purpose of the report, namely, to compare the requirements of the various states with recommendations made for certification of teachers of science, a search through the literature was made to locate such recommendations. In view of the information thus obtained, it was decided to compare the data in Table I with recommendations made in (1) the Forty-Sixth Yearbook of the National Society for the Study of Education,[8] (2) Report No. 4, The AAAS Cooperative Committee on Science Teaching,[9] and (3) evidence from an article already cited.[10]

The recommendations of the NSSE for science requirements for certifying teachers of high-school science are found in Table II.

[8] *Science Education in American Schools*, Forty-Sixth Yearbook of the National Society for the Study of Education, Part I. Chicago: Distributed by the University of Chicago Press, 1947, p. 278.

[9] The Cooperative Committee on the Teaching of Science and Mathematics of the AAAS, "The Preparation of High School Science and Mathematics Teachers," Report No. 4. School Science and Mathematics, XLVI (February, 1946), 107–118.

[10] George Greisen Mallinson and Conway C. Sams, *op. cit.*

TABLE II. RECOMMENDATIONS OF THE NSSE FOR CERTIFYING TEACHERS OF HIGH-SCHOOL SCIENCE

Course Requirements	Semester Hours
Junior High School Teachers of Science	
1. Orientation courses	8
2. Introductory courses in three special sciences	24
3. Specialization courses	8
4. Electives in science and in mathematics—at least	16
Senior High School Teachers of Science	
1. Orientation courses	8
2. Introductory courses in three special sciences	24
3. Specialization courses	16
4. Electives in science and in mathematics	8

The recommendations found in Report No. 4 of the Cooperative Committee are these:

"*Recommendation* 1. A policy of certification in closely related subjects within the broad area of the sciences and mathematics should be established and put into practice.

"*Recommendation* 2. Approximately one-half of the prospective teacher's college program should be devoted to courses in the sciences. (Sixty semester hours, divided among three subjects will allow for a 24-hour major in one science subject and 18 hours in each of two others.)

"*Recommendation* 3. Certificates to teach general science at the 7th, 8th, or 9th grade level should be granted on the basis of a broad preparation including college courses in all the subjects concerned in general science."

The investigation by Mallinson and Sams indicates *to a limited extent* the number of semester hours of science that seem sufficient in order to assure that student teachers in science are as successful on science tests as are high-school pupils. Table III contains this information.

TABLE III. SEMESTER HOURS OF COLLEGE SCIENCE NEEDED FOR COMPETENCE

Field of Science	Semester Hours		
	Short-Answer	Essay Type	Composite
Earth Science	—	11	11
Biology	—	20	16
Physics	5	34	6
Chemistry	5	21	9

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations that follow are subject to these limitations:

1. In many colleges, students are not allowed to graduate into the

teaching profession without having more credit in science than is required by the states for certification.

2. The data in Table I refer to "standard certificates," not to "temporary or special certificates." It is common knowledge that many teachers are teaching with such certificates and have less credit in science than is required for standard certificates.

3. No effort is being made to evaluate the merits of the recommendations of the NSSE or Cooperative Committee, or the validity of the evidence from the study by Mallinson and Sams.

However, in so far as the techniques employed in this study may be valid, the following conclusions seem justified:

1. An analysis of the data in Table I indicates that there is little uniformity in the state requirements in science for certification of teachers of science. At least seven states have not established such requirements. Some states require as many as sixty quarter hours, or forty semester hours for teaching "all sciences" or those included under areas such as biological or physical science. One state establishes specific course requirements rather than a specific number of semester hours. This lack of uniformity with respect to certification may cause problems for teachers who wish to move and teach in a different state.

2. In general, in states that have not established certification requirements in science, the task is delegated to the school districts that hire the science teachers, or to the colleges that prepare them for teaching. Thus it would seem that there is likely to be a lack of uniformity in the preparation of science teachers within these states. Therefore, it is possible, although not necessarily probable, that problems may arise if a teacher desires to accept a position in a different district within the respective state.

3. There seems to be little evidence that the certifying agencies have considered the qualifications desirable for supervisors or consultants in the areas of science. In only seven states are science requirements established for supervisors or consultants in science. In several states certification for supervisors and consultants in science have been established, but the requirements do not include courses in science.

4. A comparison of the state requirements with the recommendations of the NSSE and Cooperative Committee of the AAAS indicates that in general there are great discrepancies. One of the two following observations seems defensible:

Either (a) The agencies responsible for certification of teachers have not examined these reports and have not incorporated the recommendations within the requirements for certification of teachers.

Or (b) After having examined the recommendations did not believe that acceptance of such recommendations was desirable or necessary for the effective training of science teachers.

5. A comparison of the data in Table I with that in Table III indicates that, with respect to the student teachers participating in the study by Mallinson and Sams, state requirements in general are not sufficient to assure their competence in subject-matter.

6. It would seem that the requirements set up by the states do not demand the breadth of training that might be desirable. In most states it is possible to be certified to teach in one area of science without having credit in any other area. This would seem undesirable in view of the fact that most science teachers are expected to teach in several areas of science, and also, that there is no sharp demarcation among the various areas.

In view of the conclusions presented the following recommendations seem defensible.

1. The various societies, organizations, certification agencies and others concerned with the education of teachers of science may well reexamine cooperatively the factors involved in the training of teachers of science.

2. These groups should then establish requirements in science that seem desirable for the training of science teachers and are feasible with respect to the time available for educating them.

3. The various groups interested in the training of science teachers should exert every effort through their members to have the policies and recommendations result in more desirable requirements for certification.

LIGHT HELPS HATCHING OF DAMAGING MITE

Light plays an important part in the hatching of the fruit tree red spider, a mite that does extensive damage to common fruit trees in Europe, the United States and Canada.

This eight-legged pest belongs to the same family as spiders and is therefore not a true insect. The mite's damage is not inflicted directly upon the fruit, but its sucker-mouth robs the fruit tree leaves of sap, thus weakening the tree and making the leaf a less efficient factory for changing sunlight into energy.

Although only about half-pinhead size, the female red spider is nevertheless prolific—laying hundreds of eggs, usually on the tree's twigs, before dying. If laid in the fall, the eggs do not hatch until the following spring, and it is these winter-eggs, Dr. H. J. Hueck of the University of Leyden in Holland reports in the journal, *Nature,* whose hatchings are influenced by light. More break through the shell when exposed to the daylight than when kept in the dark. By passing light through variously colored filters, he also found that a considerably higher percentage of eggs hatched in blue light than in red.

SURVEY OF MANIPULATIVE OPERATIONS PERFORMED BY TECHNICIANS IN METALLURGICAL LABORATORIES

LESTER A. TWORK
Dearborn Junior College, Dearborn, Michigan

The Dearborn Junior College feels a great responsibility for operation as a community college in addition to serving as the first two years of university professional work. Inasmuch as the Dearborn-Detroit area is the recognized home of the automobile, it was evident that there would be many material tests and quality control measurements made in its production. Hoping to develop a curriculum to fit this community need, the writer carried on a survey to determine the opportunities for employment in the metallurgical laboratories and the fundamental operations that a technician must be able to perform. There was considerable preliminary work done before the survey started, such as the examination of professional literature, college catalogs and bulletins. After this the following procedure took place:

SURVEY CONDUCTED AS FOLLOWS:

1. A selected number of personnel people in industrial metal laboratories were interviewed to get their ideas on the manipulative techniques that are fundamental in training of metal laboratory technicians.
2. A questionnaire was sent with enclosed self-addressed envelope to all industries in the Dearborn-Detroit area that employed metal laboratory technicians.
3. Accompanying the questionnaire was a lithographic reduction of a group of pictures depicting some of the activities and equipment used at the Dearborn Junior College. These were grouped into a composite with a title in the center of the page: "Metallurgy for Technicians."
4. As a reminder, a follow-up letter was sent after a six or seven day period had elapsed.

It might be well to explain the meaning of the term technician as used in the title, since it is a broad term and is used to describe four groups of employees. The meaning intended for its usage here is a person who is an engineering aide or science aide, such as drafting specialists and laboratory technicians, requiring a year or two of pre-employment training. The product of terminal-technical training is technicians, such as control analysts, metallographers' assistants, physical testers, engineer or laboratory follow-up men, operators and maintainers of highly technical equipment, heat treat inspectors, and

technical salesmen. This personnel requires less lengthy and somewhat different training from that of professional engineers.

In nearly all cases the respondents were directors of metallurgical laboratories in which there were at least three divisions (chemical, mechanical testing, and metallographic) and in many of them a spectrographic and X-ray division. Names and addresses of respondents have been filed to be used in future correspondence.

The first part of the questionnaire was constructed to obtain answers to the following:

1. Number employed in the various divisions of a laboratory.
2. Title or job classification of those employed.
3. Level of training of those employed.

Table I shows a summary of levels of training of employees in the metal laboratory.

It will be noticed in this table that there is a relatively large number of junior college graduates employed in the metal laboratories.

TABLE I. LEVELS OF TRAINING OF EMPLOYEES IN THE INDUSTRIAL METAL LABORATORIES OF THE DETROIT AREA

Number employed	Number of laboratories employing					
	Graduates of					Other
	College or university		Junior college	High school	Trade and apprentice	
	Chemists	Engineers				
45–47			1			
42–44						
39–41		1				
36–38						
33–35						
30–32				1	1	
27–29			1			
24–26	1			1		
21–23				1	1	1
18–20	1		1			
15–17			1	1		
12–14		2	1			
9–11	3	1		2	1	
6–8	2	7	2	1		1
3–5	8	8	6	9	3	2
1–2	9	8	9	6	2	5
Median	4	5	4	4	3	2
Range	1–26	1–41	1–47	1–32	1–32	1–23

To establish a functional technical program, it was necessary to identify information needed and operations to be taught. Thus, the

next four pages of the questionnaire obtained the reactions of the directors of the metal laboratories to the list of operations or procedures that are required of (1) Routine Chemist (2) Metallographer's Assistant (3) Mechanical Tester, and (4) Heat Treat Inspector.

Table II is a summary of the results for Metallographer's Assistant. The plan of this table is typical of the others.

TABLE II. PERCENTAGE OF RESPONSES INDICATING TEACHING EMPHASIS UPON OPERATIONS FOR METALLOGRAPHER'S ASSISTANT

Operations and Procedures	Stressed	Taught	Not Needed
1. Cut-out and prepare microsections	50%	50%	
2. Photograph, develop and print	38.7	61.2	
3. Mount prints and record data	12.9	80.6	6.4
4. File important negatives and prints	12.9	74.1	12.9
5. Make-up etchants	35.4	64.5	
6. Macro-etch specimens	32.2	67.7	
7. Determine austenitic grain size	37.5	50.0	12.5
8. Determine heat cracks in steel	22.5	61.2	16.1
9. Determine quench cracks in steel	21.7	58.0	16.1
10. Determine burned steel	21.7	61.2	12.9
11. Identify fundamental microstructures in steel	64.5	25.8	6.4
12. Identify inclusions by a series of qualitative etches	25.8	58.0	12.9
13. Make a sulfur print	6.4	67.7	21.7
14. Make micro-hardness test on some bearing alloys	6.6	73.3	20.0

Some suggestions made by respondents for operations they believed should be included were the use of the slide rule to calculate results, the ability to use precision instruments (micrometer, calipers, etc.) and the care and repair of some of the instruments and apparatus and the ability to make a gas analysis.

Two of the questions on the last page of the questionnaire sought information regarding employment opportunities and general remarks on the over-all plan. The first question was stated, "If a two year curriculum involving the previously mentioned requirements plus those suggested by industry were made the basic requirements for technicians, would you consider such a person for employment?"

The replies were: twenty-five "yes," two "no," and eight no response. Of those who responded on this question, 92 percent indicated they would consider such a person for employment. This strong admission on the part of the directors of laboratories is sufficient evidence for offering a terminal-technical program. In fact a number of our boys have been employed in the past year and a half, but since the survey was made the country has started the

defense program and industry is now calling more frequently for candidates for the metal laboratories.

The following quotes are somewhat representative of the general suggestions that many of the directors offered. One director of a metal laboratory wrote the following:

"People with only two years' training sometimes work out better than those having spent the five years in obtaining a degree. The five-year man is always over-anxious of obtaining a supervisory position."

Another director commented:

"A diligent student should be able to get a good working knowledge of the requirements outlined in your curriculum. The requirements for the mechanical testing technician and the heat treat inspector could most likely be covered in less than two years' time."

Another suggested:

"Teach practical currently used techniques. Call on local chief chemists and metallurgists for methods. Books are obsolete on some items by the time they are printed. Attitude of the technician is very important, at least equal to, technical knowledge."

Conclusion

The data found by this survey suggested that the junior college graduate has adequate metallurgical training to fill the position of metal laboratory technician.

The high percentage of returns seems to indicate the junior college can readily assume the responsibility of preparing young people for useful employment in technical fields not requiring a four year college degree.

There is an active trend toward employing the two year junior college graduate rather than a dissatisfied engineer.

In the opinions of many of the directors frequent liaison between the instructors of the junior college and the chief chemist or metallurgist of the various industries would strengthen and keep a curriculum streamlined and up to date.

ANTI-COLLISION DEVICE FOR PLANES

Danger of collision in the air of two planes would be lessened by an airplane proximity indicator on which Charles Adler, Jr., Baltimore, received patent 2,560,265. Its use would require all planes to employ special transmitting and receiving equipment.

The transmitting device would send out continuously impulses of a predetermined high frequency, and they would be sent out in all directions. Receiver equipment would pick up only this frequency. By the use of a rectangular horn-type antenna, it would pick up signals only from planes flying at about the same altitude. By a device attached to the receiver, the positions of other airplanes are indicated.

THE WONDERS OF SCIENCE—A PLAY

AARON GOFF
Central High School, Newark, New Jersey

INTRODUCTION

The Science Club of Central High School has prepared this program with the knowledge that you are an audience which wants only the best. Keep your eyes open, your ears open, and your minds open. Let me introduce the man from Mars. (*A cloud produced by a CO_2 extinguisher masks the entry of the oddly garbed Man from Mars. He shakes hands with the announcer, looks over the tables, and waits at the microphone.*)

MARTIAN: Why the explosion?

ANNOUNCER: This audience wants to see only the best. Therefore we had to make you appear in a cloud of smoke. If you had walked onto the stage without any fuss, they would not have known that you are the Man from Mars.

MAR.: On my planet we have done away with explosions. We do everything through the mind. Life is very dull. We seldom even move on Mars. Why, I can recline on my easy chair and just think about a juicy steak, and there it is. I want some ice cream, and it appears before me. It is really a very dull life. I would like to thank the Science Club members for teaching me the English language and inviting me to see these very interesting exhibits.

ANN.: We have done it only in the interest of science. Even our audience knows something about science. (*Points to audience.*)

MAR.: What is that standing over there with a bag over it?

ANN.: That is Biology Bill, the mascot of the Science Club. Here, let me introduce him to you. He, too, is out of this world. (*Unveils skeleton.*)

MAR.: (*Shakes hands.*) He looks different from the rest of those people. Isn't he human?

GIRLS: He was human. Look, he has 206 bones. (*In rhythm they recite.*)

The toe bone is connected to the ankle bone,
The ankle bone is connected to the shin bone,
The shin bone is connected to the knee bone,
The knee bone is connected to the thigh bone,
The thigh bone is connected to the hip bone,
etc., etc.

and here in the back is the sacro-iliac.

STUDENT: (*Rushes over.*) That's not scientific. Let me explain.

The phalanges are attached by ligaments to the metatarsals. The metatarsals articulate with the tarsals. . . .

MAR.: (*Interrupting.*) I like it better their way (*pointing to the girls*). He shakes hands with the skeleton as it is removed from the stage.

A Boy Comes Walking on the Stage Swinging a Pail of Water.

MAR.: What is that?

BOY: That's the moon.

MAR.: The moon?

BOY: At least the moon acts like this pail of water.

MAR.: What do you mean?

BOY: Well look, I swing the pail around over my head. No water comes out, right?

MAR.: Right.

BOY: Why doesn't the water fall down on my head when I swing the pail?

MAR.: There must be some kind of force.

BOY: But that's against the law of gravity, isn't it?

MAR.: Then it must be stronger than gravity.

BOY: Exactly, this swinging force is called centrifugal force. It is stronger than the earth's pull. Therefore the water does not fall.

MAR.: What does this have to do with the moon?

BOY: It is exactly the same. If the moon should stop moving it would fall onto the earth, just as this water would fall on my head. As long as the moon keeps moving around the earth, traveling almost two million miles each month, we are safe.

Martian Walks Over to First Table.

MAR.: What do you call this demonstration?

BOY: This is the shadow that turns white.

MAR.: That sounds odd. Proceed, will you?

BOY: Observe closely, this paper is white on both sides, is it not?

MAR.: Yes.

BOY: I will cast the shadow of my face upon the paper thus. See my fine long nose and this cigar. (*Strong light.*)

MAR.: Yes?

BOY: I shall count to ten. One . . . ten. (*Light out.*) I dip the paper, and the shadow is brought out white by this solution. The light part has turned dark, and we have a white shadow. Just look at that nose! If I want to, I can make everything turn dark also. (*Light on.*) Now, you see that the whole sheet of paper is completely black. With additional solutions I can make a permanent picture of my nose if I so desire.

"Pitch Man" Walks Out with Tea Wagon.

P.M.: And now I'm goin' to show you something special. Ya see this bottle of watery looking liquid? Well it's not water, no, it's not oil, and it's not whiskey! It's somethin' special, see? Somethin' we cooked up in the chemistry lab., upstairs. It's got in it a little glucose, water, methylene blue, and sodium hydroxide, and that's no double talk, get it? This is strictly a scientific demonstration of that good art taught in Room 217. I mean chemistry. (***Mixture of: A—18 g. Glucose in 1 L. of H_2O. B—3 g. NaOH in 1 L. of H_2O With Methylene Blue. Freshly Prepared.***)

Now I'll tell you what I'm goin' to do. I'm goin' to change this harmless lookin', insipid tasting, and evil smelling liquid into a beautiful blue ink. And I'm goin' to do it very simply as you will soon see. I'm just goin' to pour the contents of this jar over into this empty one, like this, and what have I got? Here's that blue ink that I promised you. But before I give you any samples, I'm goin' to turn it back to that watery liquid. I make a few passes over it and I say (*slowly*) Biology, Chemistry, Physics, Electricity, Mathematics, the color is gone.

The Science Club is offering for sale, ounce bottles of this wonderful fluid for the small sum of $35.00. It's worth its weight in gold. Looka here. See this little bottle? I turn it over and shake it a few times and it turns blue. I let it stand and the color disappears! Magic? No, it's a genuine chemical phenomenon which can be explained easily by anyone who has studied the subject five or six years. (*P.M. walks off.*)

MAR.: Not bad. Now, how about those bells I heard ringing during the rehearsal? One of the boys said that he can ring bells three different ways.

BOY: That's right, here's the first way. I place two plates of metal in a jar like this. Here are two wires which connect the bell to these plates. There are no other wires or batteries or connections, no tricks. When I pour a little of this solution, and some from this bottle, the bell rings. Listen! That's called ringing the bell with a bottle, or, more scientifically, galvanic electricity. (***Solutions of sulfuric acid and potassium chromate.***)

MAR.: Amazing!

BOY: Here's another gadget. You'll have to ask our physics teacher to explain the details of this one. I could tell you but the audience might get bored. Now stand back and watch this light. When I bring it over to the gadget, the bell rings. I can stop it with my hand, or ring it by taking my hand away. That's called ringing the bell with a light, or more scientifically, photoelectricity.

MAR.: Astounding!

BOY: The third one is the hottest trick of all. It's really not a trick, but a very useful scientific phenomenon. A burning match actually causes the bell to ring. This involves a heat control known as a thermostat. (*Lights match and holds it to thermostat.*) Devices like this are used to control heat and electricity in almost every home and factory. It's most important part is a bar like this which consists of brass and steel. When such a bar is heated the brass gets longer than the steel part so that the whole thing curves. (*Demonstrates with compound bar.*) This is the secret of the thermostat.

MAR.: That was really wonderful. Say, where is that fellow going with that ax?

AX MAN: Uh, Huh, Whatsa matter? (*Gruffly.*)

MAR.: That's dangerous, where are you going?

AX MAN: Huh, uh, over dere.

MAR.: Why?

AX MAN: See dat ting? (*Points to model of atom.*) I'm gonna split da atom. (*Scientist rushes in and stops him, picks up the atom and points out the nucleus and the electrons. Goes over to electrical apparatus.*)

SCIENTIST: These machines will give you some idea about real atom smashers. All of the big ones use high voltages running into the millions. These three pieces of apparatus work on similar principles but are, of course, simpler and weaker. This is a static generator (*Wimshurst machine*) which can produce about twenty thousand volts by friction. See the spark? It is the same kind of electricity as lightning, or the shock you get when you walk across a rug. (*Lights fluorescent tube.*)

Here we have a Tesla coil which was built through the cooperation of the Physics and Technical departments. It also gives very high voltages by use of a principle called induction. The voltage is so high that some electricity leaks out into the air. You can see the effect better with the lights out. (*Spinner and fluorescent tube.*)

This diathermy machine was set up by the Physics Department. It discharges high voltage and high frequency electricity which is ordinarily used for medical treatments. Here it is hooked up to a special tube which is similar to the X-Ray and the television tubes. (*Cathode Ray tube.*) The beam in the tube which you can see, consists of large numbers of electrons which are attracted by a magnet, thus. When these electrons strike a piece of metal, X-Rays result.

So, you see, that we on earth have learned many of the laws which govern the physical world.

MAR.: This is truly marvelous. We had no idea that you earthmen had discovered so many of the secrets of nature. I shall return now

to my planet and tell my friends of this great body of knowledge which you call Science. (*Disappears in a cloud of CO_2 snow.*)

A LENS OF WATER

Frank Hawthorne
Hofstra College, Hempstead, N. Y.

I recall that as a child I read a story of arctic explorers who, lost without matches, in the great white stillness, fashioned from a cake of ice a lens of sufficient size and accuracy that they were able to focus the weak, oblique rays of the sun on some dry moss and set it on fire. This story intrigued me very much and later while teaching in a north western Pennsylvania high school I spent the better part of three winters trying to duplicate the feat. I am sorry to report that my experiments led me to believe that any actual explorers who tried to employ this idea would freeze to death. I first tried to mold a lens. I obtained a large lens of glass, made a plaster mold of it, filled this mold with water, and put it outside to freeze on a bitter winter night. This resulted (as I should have expected) in breaking the mold and producing a noticeably off-shaped hunk of ice full of air bubbles. I next tried pre-boiling to drive out the dissolved air and while this did result in a reduction in the number and size of the air bubbles in the ice, it did not get rid of them. Another method which suggested itself was to shape the lens from a block of clear ice. After some searching I found such a block and set to work. This procedure was also unsuccessful, for the pressure and friction associated with shaping the ice caused it to melt in a manner very unlike that which I desired. Perhaps such a lens can be made if sufficient care is used and if one works in a region having low enough temperatures. However, if some psychologist asked me to suggest a task suitable for a controlled study of frustration I think I should reply at once, "Build a fire with a cake of ice."

The big difficulty was that my concept of a lens throughout all of this experimentation was somehow associated with the idea of a lens of glass. I envisioned a clear, transparent, colorless, solid of a particular shape. Not until I overcame this mental set did I have any success. Finally, after three years of puttering, I got the idea. Why does a lens have to be solid? Quite obviously there is no reason.

This line of reasoning led me to make a lens of water. In this I was at once successful. I obtained a very large watch glass, mounted it on a portable ring stand and filled it with water. As soon as the surface became still, I discovered that this liquid plano-convex lens

had reasonably good optical properties. It gave considerable magnification. By placing an electric light bulb below the lens, I was able to project a clear image of the trade mark onto the ceiling. By mounting a large mirror above the lens and placing it in direct sunlight, I was able to build a fire. This simple lens was generally satisfactory. It is easy to extend this idea to a system of lenses and one can make a telescope that might be useful in looking at the zenith (or down a well).

If two watch glasses of the same size are placed face to face and immersed in water, it is possible to remove them with care in such a way that the region between them remains filled with water. The joint can be sealed if a semi-permanent lens is desired. The refractive index of water is less than that of glass and as a result the focal length of a water lens is quite long.

Of course, the liquid lens is common now. Television stores sell large lenses of mineral oil which enlarge the television picture so that one can see it even around a child's head.

TITANIUM METAL PRODUCED BY NEW LOWER-COST PROCESS

Step by step, the metal titanium is coming into its own. With new processes for reducing it from its plentiful ores, this structural metal is passing out of the list of the "little-knowns" into the list of "common" metals to take its place side by side with steel and aluminum.

Titanium as a common metal is passing through stages of production and applications similar to those in the history of aluminum. Both of these metals were long known before they could be produced economically by commercial processes. During World War II, the U. S. Bureau of Mines developed a method of obtaining relatively pure titanium at a reasonable cost but not low enough for general commercial production.

Since then improved processes have been developed by other agencies, both public and private. Among them is the Office of Naval Research, backed by the certainty that this metal and its alloys can serve many useful purposes in naval construction.

After several years of work by Naval Research, it is now announced that a process has been developed by which the metal can be obtained at about one-fifth of present costs. This means titanium at $1 a pound instead of the present $5-a-pound cost. The new process was developed by Horizons, Inc., Cleveland, Ohio. Pilot-plant stages in production have been reached.

Titanium is a light, strong, corrosion-resistant metal. In weight it is between steel and aluminum, being about 70% heavier than the latter. It is a structural metal, as strong as steel. Extensive uses are predicted in airplanes and in ship construction. Its principal uses will probably be in alloys. The Navy has already achieved a titanium-aluminum-chromium alloy which is expected to have extensive applications in jet aircraft.

Propellers for use on lighter-than-air ships, commonly called blimps, enable them to move forward, backward or to hover in a stationary position by means of a special transmission device. This electrically-operated transmission in the propeller hub gives quick-responding control.

GENERALIZATION OF THE PULFRICH REFRACTOMETER

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The Pulfrich* refractometer has a definite value in the optics laboratory since it requires the use of the concept of critical angle and provides a neat way for beginners to determine the index of refraction of some liquids. A diagram of the Pulfrich refractometer is shown in Figure I. A beam of monochromatic light is incident at an angle i on a cube of known refractive index n. The source must be movable around a graduated quadrant to allow the angle i to be

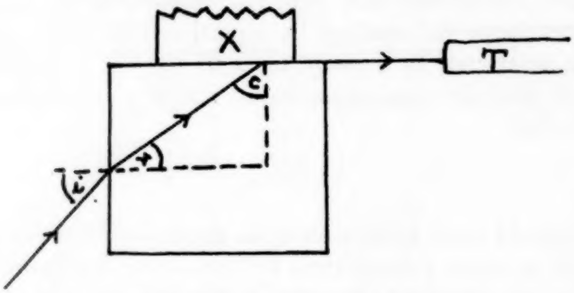

FIG. I. The Pulfrich refractometer.

known. A telescope T is fixed so that a beam of light taking a path along the top face of the cube is centered on the crosshairs. The specimen X is placed on the top of the cube. The index of refraction n' of the specimen can be determined in terms of the angle of incidense i.

When light is centered on the crosshairs again, the light is incident on the top face of the cube at the critical angle c. Applying the law of refraction, it is seen that

$$\sin r = \frac{\sin i}{n} \cdot \tag{1}$$

Noting that the critical angle c is complementary to the angle of refraction r, and writing the expression for the sine of the sritical angle, $\cos r$ is obtained in the form

$$\cos r = \sin c = n'/n. \tag{2}$$

On squaring equations (1) and (2) and adding them together, an equation is obtained which no longer contains r, namely,

* Refer to *Physics*, Hausmann-Slack for a standard discussion.

$$\frac{\sin^2 i}{n^2}+\frac{n'^2}{n^2}=\sin^2 r+\cos^2 r=1. \tag{3}$$

Solving this equation for n' yields

$$n'=\sqrt{n^2-\sin^2 i}. \tag{4}$$

This equation yields a value for the index of refraction of the specimen in terms of the index of refraction of the cube and the angle of incidence. The index of refraction of the cube is a fixed value; hence the accuracy obtainable by this type of refractometer depends upon the accuracy of the measurement of the angle of incidence i. This measurement will be discussed later.

There are two limitations placed upon the Pulfrich refractometer. Both of these limitations deal with the values that n' may possibly have in order to be determined by equation (4). Since the angle of incidence is restricted to a range from 0° to 90°, it is evident from equation (4) that the maximum value which n' may have is given when $\sin i=0$ as

$$n'_{\max}=n. \tag{5}$$

Again, this could have been seen from equation (2) since the cosine of r can have no value greater than 1. The second limitation is seldom mentioned in the few texts that treat this type of refractometer. It concerns the minimum value which is obtainable for n' and is found by placing $\sin i=1$ in equation (4). This yields

$$n'_{\min}=\sqrt{n^2-1}. \tag{6}$$

If the cube is made of glass of index of refraction 1.50 equation (5) yields 1.50 for the maximum index of refraction which can be measured and equation (6) yields approximately 1.12 for the lowest index of refraction that can be determined by equation (4). Since most liquids have a refractive index which is higher than this value, this second limitation is not a serious one for determining the index of refraction of liquids. This probably accounts for its seldom being mentioned.

A General Refractometer

A more general refractometer is that diagrammed in Figure II where essentially the same physical situation remains, but instead of a cube, a right angle prism is used. The prism angle is denoted by A. All other quantities have the notation used in the preceding paragraphs. Observing Figure II, it is noted that

(7) $$A+(90°-r)+(90°-c)=180°.$$

Solving equation (7) for r yields

(8) $$r=A-c.$$

From the relation for the cosine of the difference of two angles,

(9) $$\cos r=\cos(A-c)=\cos A\cos c+\sin A\sin c.$$

Since $\sin c=n'/n$, equation (9) can be rewritten in the form

(10) $$\cos r=\sqrt{\frac{n^2-n'^2}{n^2}}\cos A+\frac{n'}{n}\sin A.$$

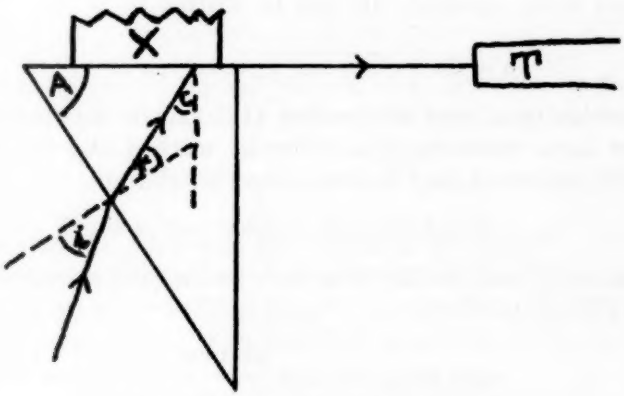

FIG. II. A more general refractometer.

From equation (1) another expression for $\cos r$ may be obtained, namely,

(11) $$\cos r=\sqrt{1-\sin^2 r}=\sqrt{\frac{n^2-\sin^2 i}{n^2}}\cdot$$

Equating the right-hand members of equations (10) and (11), the angle of refraction r is eliminated. The resulting equation is

(12) $$\sqrt{\frac{n^2-\sin^2 i}{n^2}}=\sqrt{\frac{n^2-n'^2}{n^2}}\cos A+\frac{n'}{n}\sin A,$$

or

(13) $$\sqrt{n^2-n'^2}\ \text{son}\ A=n'\sin A-\sqrt{n^2-\sin^2 i}.$$

On squaring both sides of equation (13), it is seen that

$$(14)\qquad (n^2-n'^2)\cos^2 A = n'^2 \sin^2 A + n^2 - \sin^2 i - 2n' \sin A\sqrt{n^2-\sin^2 i}.$$

On rearranging terms and considering that $\cos^2 A+\sin^2 A=1$, it is found that

$$(15)\qquad n'^2-2n' \sin A\sqrt{n^2-\sin^2 i}+n^2-\sin\ i-n^2\cos^2 A=0.$$

Equation (15) is a quadratic equation which yields a solution for n' of the form

$$(16)\qquad n'=\sin A\sqrt{n^2-\sin^2 i} \pm\sqrt{\sin^2 A(n^2-\sin^2 i)-(n^2-\sin^2 i-n^2\cos^2 A)}.$$

In a better form, equation (16) can be written as

$$(17)\qquad n'=\sin A\sqrt{n^2-\sin^2 i}\pm\cos A\sin i.$$

The ambiguity of sign in equation (17) can be eliminated if one solves the same problem by a different method. By this method equation (8) is solved for c to determine the relation

$$(18)\qquad \sin c=\sin (A-r)=\sin A\cos r-\cos A\sin r.$$

But equation (1) and the fact that $\sin c=n'/n$ can be combined with equation (18) to yield

$$(19)\qquad \cos r\sin A=n'/n+\frac{\sin i\cos A}{n}\cdot$$

Multiplying equation (1) on both sides by $\sin A$ and combining the square of both sides of the resulting equation with the square of both sides of equation (19) yields

$$(20)\qquad (\sin^2 r+\cos^2 r)\sin^2 A =\frac{n'^2+2n'\sin i\cos A+\sin^2 i\cos^2 A+\sin^2 i\sin^2 A}{n^2}\cdot$$

On multiplying both sides by n^2 and considering that $\sin^2 r+\cos^2 r=1$, equation (20) becomes a quadratic equation in n' whose solution is

$$(21)\qquad n'=-\sin i\cos A\pm\sin A\sqrt{n^2-\sin^2 i}.$$

Equation (21) and equation (17) must be in complete agreement. Therefore the signs are determined so that a final solution for n' is

$$(22)\qquad n'=\sin A\sqrt{n^2-\sin^2 i}-\sin i\cos A.$$

This allows a calculation of n' from measured quantities. It is evident

that if $A = 90°$, equation (22) is identical with equation (4). Therefore, the Pulfrich refractometer is a special case of this more general refractometer.

Now for a fixed value of A, the first term in equation (22) is a maximum when $i = 0°$. Also, the second term is then a minimum in absolute value. Hence, it follows that the maximum value of n' that can be calculated by equation (22) is

$$n'_{\max} = n \sin A. \tag{23}$$

Also, the first term of equation (22) is a manimum when $i = 90°$, and the second term is a maximum in absolute value for $i = 90°$. Therefore, the minimum value of n' that can be calculated from equation (22) is

$$n'_{\min} = \sin A \sqrt{n^2 - 1} - \cos A. \tag{24}$$

From these equations, several miscellaneous facts can be derived.

A range of usefulness can be derived for any prism of angle A by calculating the values of $n'_{\max}$ and $n'_{\min}$. For example: if $A = 60°$ and $n = 1.50$, equation (23) yields $n'_{\max} = 1.30$ and equation (24) shows that $n'_{\min} = 0.58$.

Considering the physics of the situation, the smallest prism angle that can possibly be used to determine the index of refraction of a substance is given by setting $n'_{\max} = 1$ in equation (23). This shows that approximately 42° is the smallest angle allowable for a prism to yield values for n'.

Accuracy

It is desirable to know which prism angle A will give a maximum theoretical accuracy. According to equation (22), for any given angle A, the measurement of the angle of incidence i will determine a value of n'. It is required to find the prism angle which will make a maximum of di/dn'.

Solving equation (22) for sin i yields

$$\sin i = \pm \sin A \sqrt{n^2 - n'^2} - n' \cos A. \tag{25}$$

Since $n' \leqq n$ by the limitations already mentioned, it is possible to make the substitution $\sin B = n'/n$. This defines the quantity B. Then equation (25) becomes

$$\sin i = n(\sin A \cos B - \cos A \sin B) = n \sin (A - B). \tag{26}$$

Solving equation (26) for i yields

$$i = \sin^{-1} [n \sin (A - B)] = f[A, B(n')]. \tag{27}$$

Taking the total differential and using the notation introduced in equation (27) yields

$$di=\frac{\partial f}{\partial B}\,\frac{\partial B}{\partial n'}\,dn'+\frac{\partial f}{\partial A}\,dA. \tag{28}$$

Since n' can be varied independently of A, $dA/dn'=0$, and division of equation (28) by dn' yields

$$\begin{aligned}\frac{di}{dn'}&=\frac{-n\cos(A-B)}{\sqrt{1-n^2\sin^2(A-B)}}\cdot\frac{1/n}{\sqrt{1-n'^2/n^2}}\\&=\frac{-\cos(A-B)}{\sqrt{1-n^2\sin^2(A-B)}\cos B}.\end{aligned} \tag{29}$$

The sign of di/dn' is not important because the direction of the change in i does not matter. Thus equation (29) can be used to discover when di/dn' is a maximum in absolute value. This will also show the value for which maximum theoretical accuracy is obtained It is seen from equation (29) that if $A=B$, the numerator has its largest possible absolute value. Also, the denominator has its smallest real value if $A=B$ for any given value of B. This shows that a maximum accuracy is obtained if

$$A=B=\sin^{-1}\frac{n'}{n}. \tag{30}$$

This indicated that if $n=1.50$ and one wished to measure the index of refraction of water, the best prism to use would be a right angled prism with one angle having a value $\sin^{-1} 1.33/1.50=\sin^{-1} 0.89$. For substances of slightly smaller index than the index of water it is clear that a prism angle of 60° would be good. And from the calculation $\sin^{-1} 1.00/1.50=\sin^{-1} 0.67$ it is clear that for substances having an index of refraction near unity, it would be nice to use a prism angle of 45°.

If a choice is given between two prism angles, it is necessary to calculate di/dn' for the two prisms by using equation (29). The prism which corresponds to the largest value of di/dn' will give the best theoretical accuracy. Of course, in all of these considerations, it is assumed that an approximation of the value of n' is known.

Conclusion

It is concluded that for measuring the index of refraction of some substances, a prism used in the general refractometer described herein may give higher theoretical accuracy than the Pulfrich re-

fractometer. In particular, from equation (30) it can be seen that the Pulfrich refractometer will give the highest theoretical accuracy only if the value of n' is nearly equal to the value of n.

THREE-DIMENSIONAL EDUCATION—HOME MADE

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Audio-visual education and even multi-sensory education is frequently limited to projected materials. In its fullest sense it should be termed *three-dimensional* to include materials which can be made and handled for learning purposes; models, mockups, exhibits, as well as charts and pictorial materials.

At the 1950 Science Convention held in Chicago during the Thanksgiving holiday the writer demonstrated a few home made materials which were developed for use in teaching about the earth.

For an understanding of the earth-sun relationships a model was shown in which the earth and its moon were made to revolve around a light bulb sun. The entire unit was designed as a lamp with the base turned from wood and at no cost except that of the cord and the light socket. Such a model, commercially made, would be prohibitive in price for some schools, yet a little ingenuity and time produces a device just as satisfactory for demonstrating causes of day and night, causes of seasons, meaning of the year, and causes of eclipses.

To portray the earth as a planet with physiographic features, a home made chart was shown which was done to scale. It showed a cross section to the center of the earth, with earth layers indicated and described. The oceans and continents were shown with data pertinent to their formation and conditions. Surface irregularities, mountain and ocean depths, as well as the layers of the atmosphere were also shown in scale. In addition the chart contained a great deal of other pertinent data. Such a chart is not available from any commercial source to this writer's knowledge. Yet it is almost essential in teaching about these aspects of the earth. Again there was no cost involved though the data on the chart represented very intensive research in a wide variety of sources all gathered together in one graphic presentation which has been invaluable in actual teaching situations.

To deal dramatically with igneous activities on the earth two articles were shown—one a chart which was made to show a volcano in cross section together with a variety of related materials, the other a model of a volcano which could be made to erupt very

realistically by igniting ammonium bichromate in the crater with a bit of gun powder in the bottom to provide a spectacular but harmless climax.

A large scale chart of the earth's atmosphere was next shown. This portrayed in scale the surface of the earth, highest mountains, deepest oceans, average ocean depth, average continental heights, deepest mines, wells, submarine and diving bell descents, highest airplane, balloon and rocket flights, the layers of the air, meteor and auroral phenomena and numerous other data. Here again it was possible to have in one chart information graphically presented which would otherwise take pages and pages of text or hours of talk, always at the risk of boredom.

Finally a large chart showing the wind systems of the earth and their specific causes was shown. This chart was developed as background for weather study. Basic to such study is a knowledge of atmospheric circulation which is far easier to grasp pictorially than through reading or discussion.

No attempt is made to disparage the value of the more conventionally accepted projected or electronic audio-visual aids. This writer simply wishes to emphasize that there is a real place for making things that work and for portraying in pictorial or graphic form information that might not otherwise be readily available. Home made two or three dimensional equipment is a challenge to teacher and pupils alike. It calls for some interest and ingenuity, a modicum of art knowledge and the willingness to devote time and effort to work which has genuine value in the teaching process. The teacher who wants everything ready made and who is unwilling to give of him or herself will not be much impressed. This was not meant for such people. The other kind may be stimulated to try some of these ideas and that is all the demonstration was intended to do.

BOTTLED GAS FOR BUSES

One way to conserve gasoline for automobiles and airplanes is to use "bottled gas" for fuel in city buses. Millions of country homes are now using it for cooking. A goodly number of buses are now using it as fuel, enough to prove that it provides satisfactory and economical power.

"Liquid petroleum gas" is the name by which this fuel is known in the oil industry. It is called LPG for short. Chemically, it is composed of propane and butane. These gases come to the surface of the ground along with the petroleum in many oil fields. They are also produced as a by-product in the manufacture of gasoline. They can be liquefied by pressure and shipped and used from portable tanks with safety.

Phillips Petroleum Company scientists estimate that there are nine gallons of LPG available from our current petroleum reserves for every 10 gallons of gasoline. Full recovery and use, they recently told the American Petroleum Institute, would increase the life of our petroleum reserves by more than 50%.

MISCONCEPTIONS CONCERNING CONSTRUCTION WORK IN GEOMETRY

MARTIN HIRSCH
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Work in compass and straightedge constructions is generally regarded as forming an integral part of a first course in geometry and consumes a fair portion of the year's work. There are, however, certain general misconceptions concerning the nature of this work, which is felt to be worthy of clarification.

To begin with, work of this kind is, contrary to general belief, both unnecessary and actually of no direct bearing either to the subject as taught or to the development of geometry in general. This fact has not been overlooked in textbooks. For example, in a section dealing with geometric constructions, Schultze, Sevenoak, and Schuyler[1] have the following to say: "They form, however, no logical part of plane geometry, and may be omitted without affecting the course." Criticism in this connection is directed at the fact that neither the textbooks nor the teachers lay sufficient stress on this point. In contrast to the quote offered, it is a fair assumption that most pupils feel the work in construction to be a very definite and integral part of geometry.

The development of geometry is presented to pupils as based upon a sequence of logically derived conclusions stemming from a given set of axioms. Its independence to measurement and drawings is made clear. Work with the compass and straightedge, however, tends to create an impression in direct contrast to this principle. As an illustration, suppose that in the proof of a theorem or exercise, it is required to draw a line parallel to a given line AB. The usual procedure in the proof is to say, "Draw CD parallel to AB," and to give as the reason, "A straight line can be constructed from a given point parallel to a given straight line." In this connection, two points are deserving of clarification. First, the construction is possible only in theory assuming that the construction instruments have perfect precision, which, of course, they do not. Second, and more important, the actual construction of the parallel line is of no consequence and unnecessary for purposes of the proof. The statement, "A line can be constructed through a given point parallel to a given line" is misleading in that it gives the impression that the proof is dependent upon our ability to construct the parallel. This impression is further supported by the fact that the pupil has actually learned to construct a line parallel to a given line. A more accurate represen-

[1] A. Schultze, F. Sevenoak, F. Schuyler, "*Plane and Solid Geometry*," The Macmillan Company, New York.

tation of the statement would be, "Let *CD represent* a line parallel to *AB.* "No suggestion should be made as to its constructibility. As to the existence of such a parallel, we shall accept it as axiomatic. The pupil should be made to realize that the significance of the line lies solely in its value as a visual aid and that the proof consists merely in the logically developed sequential steps. This principle can be extended to diagrams in general. It should be pointed out that all diagrams in proofs serve merely as visual aids and as such are not part of the proofs. This is a point, sometimes overlooked, which is nevertheless important for a clear understanding of the nature of proof in geometry.

Another common misconception concerns the nature and role of the compass and straightedge as construction instruments. Although the selection of the compass and straightedge as construction instruments is purely arbitrary, these instruments are thrust upon the pupil as though ordained by a power above. We feel that this arbitrary selection of the compass and straightedge should be brought to the attention of the pupils. It should also be pointed out that in being restricted to the compass and straightedge, the pupil is in effect being asked to do things the "hard way." Certainly most if not all of the traditional construction exercises would be simplified were measurement with a ruler or the use of a protractor permitted. Actually, as far as the writer has been able to discover, no better reason than the one of tradition can be offered for the restriction to the compass and straightedge. Lack of a more appealing reason should not, however, result in nothing being said in this connection. For the purpose of additional clarification as well as for general interest, a brief discussion by the teacher of other methods of construction such as Mascheroni's[2] and Steiner's[3] is felt to have value. An excellent discussion of these methods may be found in Courant and Robbins, *What is Mathematics?* As a means of reconciling the various "tools" of construction work, it should further be pointed out that all constructions, whether of the Mascheroni type, the Steiner type or the traditional compass and straightedge type, are in effect artificial devices and amount to mere "tricks" in a sense.

It should not be felt that the comments offered aim in any way to detract from the value of work in construction. Actually, we feel that work in construction has considerable value in establishing more firmly concepts such as parallel, perpendicular, bisector etc. It has value in that some of the exercises, particularly the more advanced

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[2] Mascheroni (1750–1800) proved that all geometrical constructions possible with compass and straightedge can be made by the compass alone.

[3] Steiner (1796–1863) proved that all constructions which are possible with compass and straightedge are possible with straightedge alone, provided that a single fixed circle and its center are given

ones, call for genuine mathematical thinking and originality. It has value in that it calls for rigid standards of accuracy and neatness. Our comments have been made with the hope of clearing up certain misconceptions, without whose clarification the pupil cannot gain a true perspective of the work in construction and its place in geometry.

PROBLEM DEPARTMENT

Conducted by G. H. Jamison
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

Late Solutions

2241. *W. E. Williams, Austin, Texas.*

2244. *C. W. Trigg, Los Angeles City College.*

2245. *Proposed by Dwight L. Foster, Florida A & M College.*

If $x>1$, prove that

$$\frac{1}{x}+\frac{1}{2x^2}+\frac{1}{3x^3}+\cdots=\frac{1}{x-1}-\frac{1}{2(x-1)^2}+\frac{1}{3(x-1)^3}-\cdots.$$

(*Elem. Algebra*, Hall & Knight, Macmillan, London, Page 394, No. 15.)

Solution by Dwight L. Foster, Florida A & M College

$$\frac{1}{x}+\frac{1}{2x^2}+\frac{1}{3x^3}+\cdots=-\left\{-\frac{1}{x}-\frac{1}{2x^2}-\frac{1}{3x^3}-\cdots\right\}$$

$$=-\log_e\left(1-\frac{1}{x}\right)\quad\text{when}\quad x>1,$$

$$=\log_e\frac{x}{x-1}$$

$$=\log_e\left(1+\frac{1}{x-1}\right)$$

$$=\frac{1}{x-1}-\frac{1}{2(x-1)^2}+\frac{1}{3(x-1)^3}-\cdots.$$

Solutions were also offered by: V. C. Bailey, Evansville, Ind.; Roy Wild, University of Idaho; C. W. Trigg, Los Angeles City College; Samuel Kaniel, Haifa, Israel.

2246. *Proposed by Jerome M. Glick, Brooklyn, N. Y.*

If $(pma+qmb+rnc+snd)$ $(pma\quad qmb-rnc+snd)=(pma-qmb+rnc-snd)$ $(pma+qmb-rnc-snd)$ then $a/c=b/d$, if $p=2$, $q=6$, $r=3$, $s=9$.

Solution by Bro. James F. Gray, S.M., Maryhurst, Kirkwood, Mo.

Let the A, B, C, and D, respectively, represent the four quantities in the first parentheses, and then form the proportion:

$$\frac{A+B+C+D}{A+B-C-D}=\frac{A-B+C-D}{A-B-C+D}.$$

Then by addition and subtraction:

$$\frac{2(A+B)}{2(C+D)}=\frac{2(A-B)}{2(C-D)}.$$

Now by alternating:

$$\frac{A+B}{A-B}=\frac{C+D}{C-D}.$$

Again changing by addition and subtraction:

$$\frac{2A}{2B}=\frac{2C}{2D}\quad\text{or}\quad\frac{A}{B}=\frac{C}{D}.$$

Restoring the given values:

$$\frac{pma}{qmb}=\frac{rnc}{snd}\quad\text{or}\quad\frac{pa}{qb}=\frac{rc}{sd}.$$

Replacing p, q, r, s by their values:

$$\frac{2a}{6b}=\frac{3c}{9d}.$$

whence

$$\frac{a}{b}=\frac{c}{d}\quad\text{or}\quad\frac{a}{c}=\frac{b}{d}.$$

Solutions were also offered by: C. W. Trigg, Los Angeles; Franklin Delana Roth, Cape Girardeau, Mo.; Dwight L. Foster, Tallahassee, Fla.; Martin Hirsch, Brooklyn; Margaret F. Willerding, St. Louis; D. P. Hildebrandt, Valpáraiso, Ind.; Margaret Joseph, Milwaukee.

2247. *Proposed by Norman Anning, University of Michkgan.*

Find the necessary and sufficient condition that $f(x)=ax^2+bx+c$ and $\phi(x)=px^2+qx+r$ have a common factor.

Solution by C. W. Trigg, Los Angeles City College

If $f(x)$ and $\phi(x)$ have a common factor it is also a factor of $p[f(x)]-a[\phi(x)]$ or

of $(bp-aq)x+(cp-ar)$. Therefore the necessary and sufficient condition that $f(x)$ and $\phi(x)$ have a common factor is that $f[(ar-cp)/(bp-aq)]=0$. That is, that $(cp-ar)^2=(bp-aq)(cq-br)$. If both sides of the last equation vanish, then the common factor is a quadratic one.

A Second Solution by V. C. Bailey, Evansville, Ind.

Sylvester's method of elimination gives us

$$\begin{vmatrix} a & b & c & 0 \\ 0 & a & b & c \\ p & q & r & 0 \\ 0 & p & q & r \end{vmatrix} = 0.$$

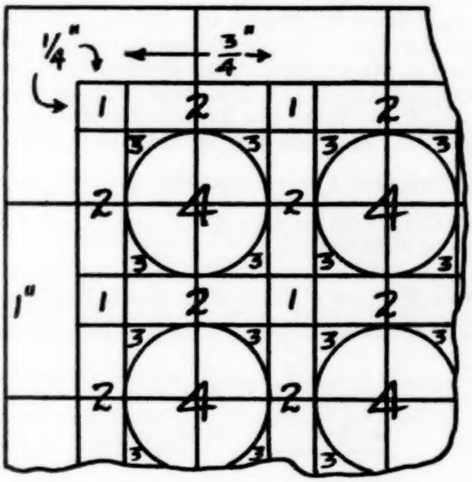
Then

$$(aq-pb)(br-qc)=(ar-pc)^2.$$

Solutions were also offered by: Walter R. Warne, Alton, Ill.; Dwight L. Foster, Florida A & M College; Cecil B. Read, University of Wichita; Martin Hirsch, Brooklyn; Roy E. Wild, Moscow, Idaho.

2248. *Proposed by Julian H. Braun, Illinois Institute of Technology.*

If a penny (diameter $=\frac{3}{4}''$) is dropped on the linoleum floor of a $10'$ by $10'$ room, the linoleum having a checkerboard pattern of $1''$ squares, what is the probability that the penny will overlap parts of three (and only three) squares?



Solution by C. W. Trigg, Los Angeles City College

It is assumed that the penny will lie flat on the floor, and that the probability that the penny will fall on one portion of the floor is equal to the probability that it will fall on any other portion of the floor. The floor contains $(120)^2$ one-inch squares. The *center of the penny* cannot lie closer than $\frac{3}{8}''$ to the edge of the floor, so it is restricted to an area S of $(120-\frac{3}{4})^2$ or $(477/4)^2$ square inches.

The figure indicates the areas in which the center may lie while the penny overlaps $k=1$, 2, 3 or 4 and only k squares. In each case the probability p of overlapping is equal to area A in which the *center* may lie divided by S. Thus we have

k	A (sq. in.)	p
1	$(120)^2\times(1/4)^2$ or 900	$900/(477/4)^2 \doteq 0.063289$
2	$2(119)(120)(1/4)(3/4)$	$85680/227529 \doteq 0.376567$
3	$(119)^2(3/4)^2-\pi(357/954)^2$	$(4-\pi)(357/954)^2 \doteq 0.120208$
4	$(119)^2\times\pi\times(3/8)^2$	$\pi(357/954)^2 \doteq 0.439936$

This problem may be generalized to give the probability p_k of overlapping k squares on a square floor of n^2 squares of side b with a coin of diameter $d<b$. Thus

$$p_1=n^2(b-d)^2/(nb-d)^2$$
$$p_2=2nd(n-1)(b-d)/(nb-d)^2$$
$$p_3=(4-\pi)d_2(n-1)^2/4(nb-d)^2$$
$$p_4=\pi d^2(n-1)^2/4(nb-d)^2.$$

Solution were also offered by the proposer; Samuel Kaniel, Haifa, Israel.

2249. *Proposed by Dwight L. Foster, Florida A. & M. College.*

Prove that $(y-z)^3+(x-y)^3+3(x-y)(x-z)(y-z)=(x-z)^3$.

Solution by Margaret F. Willerding, Harris Teachers College, St. Louis, Mo

This is merely a question of expanding the left side of the identity. When you expand the left member of this identity and collect terms you have

$$x^3-3x^2z+3xz^2-z^3=(x-z)^3.$$

Solutions were also offered by: Martin Hirsch, Junior High, Brooklyn; James F. Gray, Kirkwood, Mo.; Olivia Franzen, Milwaukee, Wis.; Roby Fretwell, Canton, Mo.; Helen Keefer, Mt. Pleasant, Iowa; Richard D. Springs, York Harbor, Me.; Alva E. Joseph, Los Angeles; Cecil B. Read, University of Wichita; Walter R. Warne, Alton, Ill.; C. W. Trigg, Los Angeles; Norman Miller, Michigan College of Mining and Tech.; Margaret Joseph, Milwaukee, Wis.

2250. *Proposed by Clara Love, Chevy Chase, Md.*

If in triangle ABC, $(a^2+b^2)\sin(A-B)$ $(a^2-b^2)\sin(A+B)$ show that the triangle is isosceles or right angled.

Solution by Margaret F. Willerding, Harris Teachers College

Substituting the formulas for the sine of the sum and difference of two angles we have,

$$a^2\cos A\sin B=b^2\sin A\cos B \tag{1}$$

$$\frac{\sin B}{b}\cdot a\cos A=\frac{\sin A}{a}\cdot b\cos B. \tag{2}$$

Since

$$\frac{\sin B}{b}=\frac{\sin A}{a}$$

by the law of sines, (2) is merely

$$a\cos A=b\cos B$$

$$\frac{\cos B}{\cos A}=\frac{a}{b}=\frac{a/c}{b/c}\,. \tag{3}$$

(3) is only true when ABC is right angled, or when ABC is isosceles, for then $a=b$ and $\cos A=\cos B$, and (3) is merely the identity $1=1$.

Solutions were also offered by: Vic Louma, Michigan College of Mining and Tech.; James Gray, Kirkwood, Mo.; Martin Hirsch, Brooklyn; Nicholas Kushta, Arlington Heights, Ill.; L. H. Lange, Valparaiso University, Ind.; Walter R. Warne, Alton, Ill.; C. W. Trigg, Los Angeles; Dwight L. Foster, Florida A & M; Samuel Kaniel, Haifa, Israel.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

2246, 9. *Kathleen Mason, and Richard Brown Winchester, Ill.*

2242. *W. Deeks, Upper Canada College, Toronto.*

2233, 8. *G. West, Upper Canada College, Toronto.*

2234. *A. C. Pathy, Upper Canada College, Toronto.*

2241, 6, 50. *W. M. H. Groves, Upper Canada College, Toronto.*

2246. *Richard Hull, Edwin Munson, Richard Lull, Phyllis Kodoyama, Richard Lane all of Arlington Heights, Ill.*

2246, 9. *Clyde Lindner, Red Bank, N. J.*

2246. *David Freeman, Exter, N. H.; A. C. Pathy and G. Deeks, Toronto.*

2247, 9, 50. *A. C. Pathy and G. Deeks, Toronto.*

2249. *Annette Barron, Wilmington, Calif.*

PROBLEMS FOR SOLUTION

2263. *Proposed by Dwight L. Foster, Florida A and M College*

If x, y, z be unequal, and if $2a-3y=(z-x)^2/y$ and $2a-3z=(x-y)^2/z$, then show that $2a-3x=(y-z)^2/x$ and $x+y+z=a$.

2264. *Proposed by Dwight L. Foster, Florida A and M College.*

Prove that cx^2-ax+b is a common division of ax^3-bx^2+c and bx^3-cx+a if it is a divisor of either one of them.

2265. *Proposed by C. W. Trigg, Los Angeles City College.*

Along a straight road a farmer had planned to fence off two equal square plots of a given area. He found that the available frontage was two feet short. But by using two more feet of fencing he was able to fence in the two square plots of the desired total area. What were the sides of the plots?

2266. *Proposed by Cecil B. Read, University of Wichita.*

PQ is a straight line drawn through O, one of the common points of two circles. If P and Q are points, one in each circle, find the locus of point S, which bisects PQ.

2267. *Proposed by Howard D. Grossman, New York.*

The center of gravity of a thin homogenous triangular plate coincides with that of three equal masses at the vertices of a triangle.

Also show that the center of gravity of a thin homogenous quadrangular plate does not coincide with that of four equal masses at the vertices unless the quadrilateral is a parallelogram.

2268. *Proposed by Alan Wayne, Flushing, N. Y.*

In triangle ABC prove that the maximum value of $(\sin A+\sin B+\sin C)(\cos A+\cos B+\cos C)=9\sqrt{3}/4$.

BOOKS RECEIVED

Fundamentals of Electrical Engineering, by Fred H. Pumphrey, *Head Department of Electrical Engineering, University of Florida.* Cloth. Pages xii+668. 14×21.5 cm. 1951. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $5.75.

Methods and Activities in Elementary-School Science, by Glenn O. Blough, *Specialist in Elementary Science, United States Office of Education,* and Albert J. Huggett, *Associate Professor of Education, School of Science and Art, Michigan State College.* Cloth. Pages viii+310. 18.5×25.5 cm. 1951. The Dryden Press, The Dryden Press Building, 31 West 54th Street, New York 19, N. Y. Price $3.75.

Basic Organic Chemistry, by J. Rae Schwenck, Ch.E., and Raymond M. Martin, M.S., *Sacramento Junior College, Sacramento, California.* Cloth. Pages ix+323. 15×23 cm. 1951. The Blakiston Company, 1012 Walnut Street, Philadelphia 5, Pa. Price $4.50.

College Algebra, by Henry L. Rietz, *Late of the University of Iowa,* and Arthur R. Crathorne, *Late of the University of Illinois.* Fifth Edition, Revised by J. William Peters, University of Illinois. Cloth. Pages xv+387. 13.5×21 cm. 1951. Henry Holt and Company, 257 Fourth Avenue, New York 10, N. Y. Price $2.95.

Brief Course in Analytics, Revised Edition, by M. A. Hill, Jr., and J. B. Linker, *University of North Carolina.* Cloth. Pages xi+224. 13.5×20 cm. 1951. Henry Holt and Company, 257 Fourth Avenue, New York 10, N. Y. Price $2.40.

Analytic Geometry, Second Edition, by John W. Cell, *Professor of Mathematics, North Carolina State College of Agriculture and Engineering, University of North Carolina.* Cloth. Pages xii+326. 13.5×21.5 cm. 1951. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $3.75.

Climate in Everyday Life, by C. E. P. Brooks, I.S.O., D.Sc., F.R.Met. Soc. Cloth. 314 pages. 13×21.5 cm. 1951. The Philosophical Library, 15 East 40th Street, New York 16, N. Y. Price $4.75.

Aluminum from Mine to Sky, by June Metcalfe. Cloth. 128 pages. 15×23 cm. 1947. Whittlesey House, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y.

Space, Time, Matter, by Hermann Weyl. Translated from the German by Henry L. Brose. First American Printing of the Fourth Edition, 1922. Cloth. Pages xvi+330. 13×20.5 cm. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $3.95.

Vacuum-Tube Voltmeters, by John Rider, Revised by John F. Rider and Alfred W. Barber. Cloth. Pages ix+422. 13.5×21 cm. 1951. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $4.50.

Literary Style and Music, by Herbert Spencer. Cloth. Pages x+119. 10×16.5 cm. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y.

Introductory Chemistry for Students of Home Economics and Applied Biological Sciences, by Lillian Hoagland Meyer, *Western Michigan College of Education.* Cloth. Pages x+532. 13.5×21 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.00.

Introductory College Chemistry, Fifth Edition, by Harry N. Holmes, *Oberlin College, Oberlin, Ohio.* Cloth. Pages viii+594. 13.5×21 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $4.75.

Mathematics, Book II, by J. D. N. Gasson, M.A., B.Sc., *Senior Lecturer in Mathematics, Chesterfield Technical College.* Cloth. Pages x+431. 13.5×21 cm. Cambridge University Press, American Branch, 51 Madison Avenue, New York 10, N. Y. Price $2.75.

Fundamentals of Physics, Revised Edition, by Henry Semat, Ph.D., *Professor of Physics, The City College, College of the City of New York.* Cloth. Pages xxv+849. 15×23 cm. 1951. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N. Y. Price $6.00.

Thermodynamics of Fluid Flow, by Newman A. Hall, *Professor of Mechanical Engineering, University of Minnesota.* Cloth. Pages x+278. 14×21.5 cm. 1951. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $5.50.

Aircraft Jet Powerplants, by Franklin P. Durham, *Assistant Professor of Aeronautical Engineering, University of California.* Cloth. Pages ix+326. 14×21.5 cm. 1951. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $5.00.

Inorganic Semimicro Qualitative Analysis, by Carroll Wardlaw Griffin, Ph.D., *Professor of Chemistry in Vassar College* and Mary Alys Plunkett, Ph.D., *Assistant Professor of Chemistry in Vassar College.* Cloth. Pages x+299. 15×23 cm. 1951. The Blakiston Company, Philadelphia 5, Pa. Price $4.75.

Bacteriology, Fifth Edition, by Robert E. Buchanan, *Research Professor, Emeritus Professor of Bacteriology, Dean of Graduate School, and Director of Iowa Agricultural Experiment Station, Iowa State College,* and Estelle D. Buchanan, *Formerly Assistant Professor of Botany, Iowa State College.* Cloth. Pages x+678. 13.5×21 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $6.00.

Advanced Fluid Dynamics and Fluid Machinery, by R. C. Binder, Ph.D., *Professor of Mechanical Engineering, Purdue University.* Cloth. Pages x+426. 13.5×21.5 cm. 1951. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $6.00.

Man and the Animal World, by Bernal R. Weimer, Ph.D., *Professor of Biology, Bethany College, Bethany, West Virginia.* Cloth. Pages x+569. 14.5×23 cm. 1951. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.00.

General Homogeneous Coordinates in Space of Three Dimensions, by E. A. Maxwell, *Fellow of Queens' College, Cambridge.* Cloth. Pages xiv+169. 13.5×22 cm. Cambridge University Press, American Branch, 51 Madison Avenue, New York 10, N. Y. Price $2.75.

An Introduction to Modern Psychology, by O. L. Zangwill. Cloth. Pages

xi+227. 10×16.5 cm. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $3.75.

ALGEBRA FOR COMMERCE AND LIBERAL ARTS, by Alvin K. Bettinger, *Head of Department and Associate Professor of Mathematics, The Creighton University*, and Wendell A. Dwyer, *Formerly Associate Professor of Mathematics, The Creighton University*. Cloth. Pages xi+225. 15×23 cm. 1951. Pitman Publishing Corporation, 2 West 45th Street, New York 19, N. Y.

FUNDAMENTALS OF ATOMIC PHYSICS, by Saul Dushman, Ph.D., *Research Consultant, Formerly Assistant Director, Research Laboratory, General Electric Company, Schenectady, New York*. Cloth. Pages x+294. 15×23 cm. 1951. McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y. Price $5.50.

COLLEGE ZOOLOGY, Sixth Edition, by Robert W. Hegner, Ph.D., Sc.D., *Late Professor of Protozoology in the School of Hygiene and Public Health of the Johns Hopkins University*, and Karl A. Stiles, M.S., Ph.D., *Professor of Zoology, Michigan State College*. Cloth. Pages x+911. 15×23 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $6.00.

MAN AND THE LIVING WORLD, Second Edition, by E. E. Stanford, Ph.D., Sc.D., *Stockton College, Stockton, California*. Cloth. Pages xvi+863. 13.5×21 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.50.

FOUNDATIONS OF BIOLOGY, Seventh Edition, by Lorande Loss Woodruff, *Late Colgate Professor of Protozoölogy, Director of the Osborn Zoölogical Laboratory, Yale University*, and George Alfred Baitsell, *Colgate Professor of Biology, Fellow of Calhoun College, Yale University*. Cloth. Pages xiv+719. 13.5×21 cm. 1951. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.50.

MACHINE SHOP MATHEMATICS, Second Edition, by Aaron Axelrod, Ed.D., *Teacher of Machine Shop Mathematics and Science at The Vocational and Technical High School, Bayonne, New Jersey, and Instructor of Applied Science and Mathematics, School of Education, New York University*. Cloth. Pages xi+359. 15×23 cm. 1951. The McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y. Price $3.60.

PATTERNS IN THE SKY, by W. Maxwell Reed. Cloth. 125 pages. 15.5×21.5 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.50.

EVERYDAY ALGEBRA, Intermediate Course, by William Betz, *Specialist in Mathematics, Rochester, New York*, and Alfred P. Windt, *Hempstead High School, Hempstead, Long Island, New York*. Cloth. Pages x+566. 14×20.5 cm. 1951. Ginn and Company, Statler Building, Boston 17, Mass. Price $2.48.

PRACTICAL MATHEMATICS, PART IV—TRIGONOMETRY AND LOGARITHMS, Fifth Edition, by Claude Irwin Palmer, *Late Professor of Mathematics and Dean of Students, Armour Institute of Technology*, and Samuel Fletcher Bibb, *Associate Professor of Mathematics, Illinois Institute of Technology, Armour College of Engineering*. Cloth. Pages xii+193. 13.5×20.5 cm. 1951. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $2.60.

LINEAR COMPUTATIONS, by Paul S. Dwyer, *Professor of Mathematics, University of Michigan*. Cloth. Pages xi+344. 14.5×23 cm. 1951. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.00.

MUSICAL ACOUSTICS, Third Edition, by Charles A. Culver, Ph.D., *Visiting Professor of Physics, Park College; Formerly, Head of The Department of Physics,*

Carleton College. Cloth. Pages xiv+215. 14.5×21.5 cm. 1951. The Blakiston Company, 1012 Walnut Street, Philadelphia 5, Pa. Price $4.25.

Atomic Energy in War and Peace, by Captain Burr W. Jeyson, *Author of Modern Wonders and How They Work*, etc. Cloth. 217 pages. 13.5×19.5 cm. 1951. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York 10, N. Y. Price $3.75.

Observing the Heavens, by Peter Hood. Cloth. 64 pages. 17×23.5 cm. 1951. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $1.75.

The Sea Hunters, Indians of the Northwest Coast, by Sonia Bleeker. Cloth. 159 pages. 12.5×19 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

Golden Hamsters, by Herbert S. Zim. Cloth. 63 pages. 16.5×20.5 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

Science for Everyday Use, by Victor C. Smith, *Department of General Science, Ramsey Junior High School, Minneapolis, Minnesota*, and B. B. Vance, *Chairman, Science Department, Kiser High School, and Assistant Professor of Biology and Education, The University of Dayton, Dayton, Ohio*, in Consultation, with W. R. Teeters, *Director of Education, St. Louis Public Schools, St. Louis, Missouri*. Cloth. Pages xiii+737. 14×22 cm. 1951. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Ill.

Science for Modern Living Series: Grades 2 and 3 by Victor C. Smith, *Department of General Science, Ramsey Junior High School, Minneapolis, Minnesota*, and Katherine Clarke, *The Meramec School, Clayton, Missouri*. Grade 1, Along the Way. Cloth. 128 pages. 14.5×21.5 cm. Grade 2, Under the Sun. Cloth. 160 pages. 14.5×21.5 cm. Grade 3, Around the Clock. Cloth. 160 pages. 14.5×21.5 cm. Grades 4, 5 and 6 by Victor C. Smith, and Barbara Henderson, *Director of Intermediate Education, Kansas City Public Schools, Kansas City, Missouri*. Grade 4, Across the Land. Cloth. 192 pages. 14.5×21.5 cm. Grade 5, Through the Seasons. Cloth. 224 pages. 14.5×21.5 cm. Grade 6, Beneath the Skies. Cloth. 224 pages. 14.5×21.5 cm. Grades 7, 8 and 9 by Victor C. Smith, and W. E. Jones, *Chairman, Biology Department, Evanston Township High School, Evanston, Illinois*. Grade 7, Exploring Modern Science. Cloth. 353 pages. 14.5×22.5 cm. Grade 8, Enjoying Modern Science. Cloth. 466 pages. 14.5×22.5 cm. Grade 9, Using Modern Science. Cloth. 654 pages. 14.5×22.5 cm. All books in Consultation with W. R. Teeters, *St. Louis Public Schools, St. Louis, Missouri*. 1951. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Ill.

Mathematics Essential for Elementary Statistics, Revised Edition, by Helen M. Walker, *Professor of Education, Teachers College, Columbia University*. Cloth. Pages xiii+382. 13×20 cm. 1951. Henry Holt and Company, 257 Fourth Avenue, New York 10, N. Y. Price $2.75.

The House of Life, by George A. Rubissow. Cloth. 381 pages. 15×23.5 cm. 1951. Ricardo Press, 121 West 63rd Street, New York 23, N. Y. Price $4.00.

Animal Tools, by George F. Mason. Cloth. 94 pages. 12×20.5 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

Play with Vines, by Millicent E. Selsam. Cloth. 63 pages. 15.5×20 cm. 1951. William Morrow and Company, Inc., 425 Fourth Avenue, New York 16, N. Y. Price $2.00.

Ups and Downs, A First Book about Space, by Ethel S. Berkley. Cardboard.

26 pages. 15.5×19 cm. 1951. William R. Scott, Inc., 8 West 13th Street, New York 11, N. Y.

LET'S START COOKING, by Garel Clark, Cardboard. 67 pages. 15.5×21.5 cm. 1951. William R. Scott, Inc., 8 West 13th Street, New York 11, N. Y.

A NEW THEORY OF GRAVITATION, by Dr. Jakob Mandelker, *Assistant Professor of Mechanics, Georgia Institute of Technology, Atlanta, Georgia.* Cloth. 25 pages. 14×21.5 cm. 1951. The Philosophical Library, 15 East 40th Street, New York 16, N. Y. Price $2.75.

INTERMEDIATE ALGEBRA, by Paul K. Ress, *Associate Professor of Mathematics, Louisiana State University,* and Fred W. Sparks, *Professor of Mathematics, Texas Technical College.* Cloth. Pages viii+328. 13.5×20 cm. 1951. McGraw-Hill Book Company, Inc., 330 West 42nd Street. New York 18, N. Y. Price $3.25.

THE TEACHING OF SECONDARY MATHEMATICS, Second Edition, by Charles H. Butler, *Professor of Mathematics, Western Michigan College of Education,* and F. Lynwood Wren, *Julia A. Sears Professor of Mathematics, George Peabody College for Teachers.* Cloth. Pages xiv+550. 15×23 cm. 1951. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $4.75.

ELEMENTARY SCIENCE EDUCATION IN AMERICAN PUBLIC SCHOOLS, by Harrington Wells, *Associate Professor of Science Education, University of California, Santa Barbara College.* Cloth. Pages ix+333. 15×23 cm. 1951. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $3.75.

THE TEACHING OF ARITHMETIC. The Fiftieth Yearbook of the National Society for the Study of Education. Part II. Prepared by the Society's Committee, G. T. Buswell (Chairman), Foster E. Grossnickle, Ernest Horn, Herbert F. Spitzer, Esther Swenson, C. L. Thiele, and Harry G. Wheat. Cloth. Pages xii+302+lxx. Ellis Avenue, Chicago 37, Ill. Price $3.50.

BOOK REVIEWS

AN INTRODUCTION TO THE THEORY OF STATISTICS, by G. Udny Yule, *Formerly Reader in Statistics, University of Cambridge,* and M. G. Kendall, *Professor of Statistics, University of London.* Cloth. 15×22.5 cm. 1950. Hafner Publishing Company, New York, N. Y. Price $7.00.

This fourteenth edition is a substantial revision and was prompted by the extensive advances in the statistical field during the past fifteen years.

Most of the changes are additions with some revisions in the treatment of the theory of attributes. The additions are mainly concerned with: (1) small-sample theory and practical applications of sampling, and (2) index-numbers and the elementary theory of time-series.

In addition, the chapter on practical problems of correlation has also been revised. The excellent treatment of analysis of variance has been modernized in terms of modern discoveries regarding this powerful statistical tool.

Students in education and psychology will find this text an important addition to their library.

KENNETH E. ANDERSON
University of Kansas

PHYSICAL SCIENCES FOR HIGH SCHOOLS, by, John C. Hogg, Judson B. Cross, and Elbert P. Little, in collaboration with Otis E. Alley and Albert E. Navez. Pages viii+531. 20×26 cm. 1951. D. Van Nostrand Company, Inc., New York 3, N. Y. Price $3.96.

Surveying science for general education in the eleventh and twelfth years—in chemistry, earth science, physics, astronomy, aeronautics, and meteorology—*Physical Sciences For High Schools* is intended particularly for students who are not planning to take separate courses in physics and chemistry. Interrelation, rather than the technical and mathematical aspects, of the various fields is emphasized.

Directions for one hundred twelve short teacher demonstrations of applications of the subject matter are included at appropriate points in the book. Thus one plan of enriched stimulation for pupil interest throughout the course is ready to use. Suggested student activities likely to grow out of the demonstration experiences are listed at the end of the chapters. These include a list of things to be remembered; a number of questions on the text material arranged in two groups, the first being less exacting; and projects to challenge pupil participation. References suggested for further reading conclude each unit. (The fifty-eight chapters are arranged into eleven units.)

The readability of the book is enhanced for the general education student by the authors' historical or sociological approach and by the use of analogies.

Given opportunity to arrange class time activities around the teacher demonstrations and student projects, with changes of pace to insure standards in pupil study habits, one should be agreeably rewarded with student progress in this survey of scientific knowledge and use of scientific methods. Identification and study of scientific method as such follows one hundred and ninety-six pages of progress in scientific knowledge. The abundance of material included permits ample opportunity for selection of material to be studied.

ALLEN F. MEYER
Detroit, Michigan

MODERN CHEMISTRY, by Charles E. Dull, William O. Brooks, H. Clark Met calfe. Cloth. Pages xi+564. 16.5×24.5 cm. 1950. Henry Holt and Company 257 Fourth Avenue, New York 10, N. Y. Price $3.40.

A revision of the already successful *Modern Chemistry*, of Charles E. Dull, this textbook has been brought up to date by a careful provision of consideration of both the secondary school students to be served and the subject matter.

Forty-six chapters, some descriptive, some technical, and some theoretical, have been grouped into sixteen units varying in length of from one to six chapters each. The authors have classified both the text material and the questions and problems as to degree of difficulty which might be experienced in case the book is used by those not intending to go to college. The grouping of descriptive treatment with theoretical explanations is such as to adapt to classes containing a variety of pupils. Intentionally, more chemistry is presented than need be required of any class, to allow for selection to fit local needs.

Each of the four hundred twenty-two illustrations adds to the attractiveness of the book. The fact that acknowledgments for one hundred eighty-three of the illustrations were directed to one hundred thirteen individuals or companies may be taken as one measure of the interest, participation, or cooperation involved in the preparation of this revision.

In addition to trying to keep the sentences short and the language simple, the authors have focused attention upon vocabulary growth very logically on the first page of each chapter, preliminary to the introduction of new words in the text. The conservative nature of previous books by Dull is suggested by the devoting of one paragraph to silicones in the midst of a number of industrial compounds of silicon.

The twenty-five pages of index and guide to terms are a rich source of convenience and study help, just one of the many items worthy of the reputation previous editions have enjoyed.

ALLEN F. MEYER
Detroit, Michigan

ELEMENTS OF ANALYTIC GEOMETRY, by Clyde E. Love, *Ph.D., Professor Emeritus of Mathematics in the University of Michigan.* Third Edition. Cloth. Pages xii+218. 14.5×21 cm. The Macmillan Company, New York, N. Y. 1950. Price $2.75.

This is the third edition of a text by a very well known author. In this revision the author states that the length of the text is greater, the chapter on algebraic curves is placed earlier, the amount of space devoted to conics is reduced, and material on transcendental functions included. The coverage is much more complete than in many recent texts.

The reviewer was interested in comparison with the fourth edition of the author's *Analytic Geometry*, published in 1948. To a very large extent, the books are identical. In a few cases where applications are discussed in the 1948 book, the important difference is the inclusion in the *Analytic Geometry* of four chapters not in this work: the Derivative; Tangents and Normals to the Conics; Polynomial Graphs, Maxima and Minima; and Curve Fitting.

There are very few points of criticism. On page three the author warns that in graphs the scale adopted should be clearly indicated, then violates his rule in the majority of the graphs in the text. On page 45, the statement that there is no symmetry might well have been qualified as on page 43. There seems to be no good reason for an index for solid analytic geometry, it could well be combined with that for plane analytic geometry. In the development of the normal form of the equation of the straight line the author choses to select the angle as less than 180°; this is of course a matter of choice. Without question, this book merits strong consideration as a text in the case where calculus concepts are not desired and a rather complete treatment is to be available.

CECIL B. READ
University of Wichita

LIFE INSURANCE MATHEMATICS, By Robert E. Larson, *Fellow of the Society of Actuaries; Lecturer, School of Commerce,* and Erwin A. Gaumnitz, *Professor and Assistant Dean, School of Commerce, Both in the University of Wisconsin.* Cloth. Pages vii+184. 15×23.5 cm. John Wiley and Sons, Inc., 440 4th Ave., New York 16, N. Y. 1951. Price $3.75.

This is a text in life insurance mathematics, primarily planned for the college student, not the professional actuary. The authors suggest as background a course in mathematics of finance, which seems a reasonable prerequisite. Examples are in general based on the CSO mortality tables with a 2½ per cent interest rate, reflecting present practice rather than antiquated tables; likewise current actuarial notation is employed. At the same time the authors point out that a large part in insurance now in force is based on other mortality tables, and for use in some problems a 1937 standard annuity table—2½ per cent—is given.

The text seems well written; there is an ample supply of problems, with answers; tables needed for solution of the problems are bound with the book. It is doubtful if there are many schools, other than large universities, in which a course is offered for which this book could serve as a text. If could well be argued that it might be advisable to add such a course. Even if not to be used as a text, this is a valuable addition to a college library. It would serve two purposes: it provides up to date information about many questions arising relative to the mathematics of life insurance which are not readily available elsewhere; and it provides a "bridge" between elementary texts in mathematics of investment and advanced technical works. One warning is needed: although technically no mathematics beyond high school algebra is needed, it is doubtful if some parts of the book will be handled without some degree of mathematical maturity gained through college courses or actual experience.

CECIL B. READ

THE MAIN STREAM OF MATHEMATICS, by Edna E. Kramer. Cloth. Pages xii +321. 14.5×21.5 cm. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. 1951. Price $5.00.

When the reviewer started reading this book, he could hardly put it down. The style of the first few pages (and in fact, the first pages of several of the chapters) is unusual and very attractive. For some reason, however, the feeling that this book fills a long felt need in mathematics did not continue. This comment need not detract from the general merit of the book, it simply means that the enthusiasm felt at first tapered off after reading some fifty pages.

The book is unusual. There is a great deal of history of mathematics, yet it is not a history of mathematics text, and the order of presentation of the material is not chronological. The historical material is very attractive, particularly anecdotes about various incidents in mathematical history. It is not always clear, however, whether these are historical fact, legendary, or merely historical fiction. If the last, at least there are no gross contradictions of what *might* have happened.

The publishers state that the primary purpose is to provide the layman with a popular exposition of fundamental concepts of mathematics that are important in the world today. Since it is impossible to tell the reaction of the general public, the book might become a best seller or the public might consider it a complete "flop."

The "popular exposition of fundamental concepts" portions of the book cover such topics as elementary properties of number; elementary algebra, as for example the meaning of such terms as *coefficient* and *exponent;* trigonometry. analytic geometry, calculus, probability; and terminate with a discussion of non-Euclidean geometry, relativity, and the concept of infinite classes. The treatment is well done and is refreshing to one who has been over the material; it may seem technical to one unfamiliar with these concepts. Many practical applications of mathematics are discussed more or less briefly, including mathematical problems arising in connection with the atomic bomb, radar, loran, rockets, harmonic motion, quality control, and many other topics. The historical treatment, the explanation of concepts, and the discussion of applications are not separated, but appear in a reasonably well unified whole. In the reviewer's opinion, however, the greatest merit lies in the historical portions.

Certainly this book would be a valuable addition to any teacher's personal library. While it contains much material which could be found elsewhere, it would be hard to find any single volume so likely to prove interesting to a high school or junior college student who wishes to explore some of the possibilities in mathematics. It offers almost unlimited suggestions for mathematics club programs—to mention a few instances: the chapter entitled "From Alice to Einstein"; the discussion of Zeno's paradoxes; the relation of mathematics to nature and to art. Certainly the book belongs in every college library. While the book was not written with this end in view, it might offer distinct possibilities as a text in a course in the appreciation of mathematics. There are no problems or exercises.

CECIL B. READ

BASIC MATHEMATICS FOR GENERAL EDUCATION, by H. C. Trimble, F. C. Bolser, and T. L. Wade, Jr., *Mathematics Department, Florida State University.* Cloth. Pages xiii+313. 15×22 cm. Prentice-Hall, Inc., New York, N. Y. 1950. Price $3.25.

Within reasonable bounds, the content of mathematics texts in college algebra, trigonometry, or analytic geometry is well established. With mathematics for general education, there seems to be no uniformity unless the complete lack of uniformity be considered the normal practice. Whether or not a particular text will suit a specified course is distinctly problematical.

This text starts with a chapter which discusses mathematics as a language.

Using a spiral method of presentation, the book covers among other topics the number system; equations through quadratic equations and systems of linear equations in two unknowns (a system of three equations in three unknowns is presented as a problem); ratio and variation; approximate numbers; a very brief treatment of logarithms, similar figures and indirect measurement; elementary mathematics of finance; elementary statistics.

The approach is conversational—at times the text seems a little "wordy." The exercises frequently include hints for solution (some teachers may feel too many hints are given). Answers are unusually complete, including graphs and in some cases not merely an answer but an outline of the solution. Not all answers are given, but there is no uniformity as to which ones are selected to be listed.

Some minor comments: On page 13 there is a statement not often found in a discussion of Roman numbers (XCIX is used rather than IC). This may lead the student to do some thinking as what the rule of formation is and why. The statement that the rules of multiplication and division with positive and negative integers come from definition rather than proof is debatable, particularly in view of recent discussion of this topic. In the chapter on variation, two sets of problems are given, one set for those who prefer the method of proportion, the other for those who prefer to determine a constant of variation and then use a formula. There may be a false impression given the student from the use of two sets—why not one set for which the student might employ whichever method he prefers? On page 157, it is not stated that the theoretical frequencies in the table have been rounded to integers. In discussing the extraction of square root, one method is division by successive approximations, the other the traditional method, which the authors term the "calculation form"—one wonders why the first method is not a "calculation" method. On page 217 a conclusion is drawn from a graph that the difference between the amounts at simple and compound interest gets greater as time goes on. This statement might be hard to verify in the interval, for example, from 0 to $1\frac{1}{2}$ years (which period is included in the graph).

The points mentioned are relatively minor. In general, the definitions are rigorous, with care taken to point out conditions under which they do not hold (for example, the restriction that certain laws of exponents do not hold with a zero base). In the opinion of this reviewer, one of the strongest portions of the text is the discussion of the interpretation of statistical data.

If your course covers essentially the material of this text, by all means look the book over before you make your final selection.

CECIL B. READ

PRACTICAL MATHEMATICS, PART II: ALGEBRA WITH APPLICATIONS, by Claude Irwin Palmer, *late Professor of Mathematics and Dean of Students, Armour Institute of Technology;* and Samuel Fletcher Bibb, *Associate Professor of Mathematics, Illinois Institute of Technology, Armour College of Engineering.* Fifth Edition. Cloth. Pages xiii+252. Table of Contents. Index. Answers. McGraw-Hill Book Co., New York. 1950.

This textbook not only presents the salient features of a first course in algebra, with some advanced material, but it argues mightily for the usefulness of traditional algebra by setting forth an abundance of problems drawn from the various trades and professions and tested over a period of several decades by practical men. The technique of handling the equation in the transforming of formulas and the solving of real problems, many of which are adapted from engineering journals, is admirably illustrated; but the practical slant of the material has not been allowed to diminish the emphasis on basic understandings: the theoretical discussions, though unpretentious, are entirely adequate for the scope of the book and are excellent for clearness and correctness.

The authors have shown a remarkable talent for making their book attractive and readable. It was written both for men long separated from their school days and for serious-minded younger men in trade and continuation schools. No doubt the simple, straightforward manner of relating the important ideas of

elementary mathematics has been largely responsible for the popularity of this volume and of its companions in a series of four basic textbooks. The expert selection and arrangement of material and the clear, comprehensive definitions are additional features of merit; while the problems themselves, collected in part through the collaboration of students and correspondents and drawn from actual experience, are intrinsically interesting and adaptable to courses of a less specialized character.

Teachers should examine this book not only because of its general excellence but also because it demonstrates once again the importance of a subject sometimes unappreciated for its utility and power.

W. J. CHERRY
Morton High School
Cicero, Illinois

MATHEMATICS TO USE, by Mary Potter, *Supervisor of Mathematics, Racine, Wisconsin,* and Flora M. Dunn, Emmy Huebner Allen and John S. Goldwaite. Cloth. Pages ix+441. Appendix. 16+23. Ginn and Company. 1950.

In this book the subject matter is presented in a very "readable," simple and interesting manner. The presentation of the subject matter in each chapter follows the uniform pattern of explanation, application, summary and tests. Since the book is designed for those with no intention of continuing their education in college, the authors have wisely stressed the correct usage of arithmetic with very fine explanations and drill work on fractions, decimals and percentages. In addition to the strong current of arithmetic continuing throughout the entire book, the student is also afforded the opportunity to master the most basic and necessary materials from the fields of algebra and geometry. The appendix contains formulas and other data of practical value for household and business activities. The many problems and exercises contained in this book on all subject matter provide the maximum amount of drill work to be desired by any teacher.

The book is divided into two parts, each of which provides sufficient subject matter for one semester of study. Although either part could be offered independently the fundamental operations and conceptions gained in the first part should lend themselves to a better understanding of applications necessary in the second part.

The strength of this book seems to lie in its thorough presentation of all arithmetical operations and other information in such an interesting and understandable form that even those students who suffer from a deficiency in reading ability should find it digestible.

G. B. REEVE
Morton High School
Cicero, Illinois

PLANE TRIGONOMETRY, by E. Richard Heineman, *Professor of Mathematics, Texas Technological College.* Alternate Edition. Cloth. Pages xiv+184+iv+75. 15×22.5 cm. 1950. McGraw-Hill Book Company, 330 West 42nd Street, New York 18, N. Y. Price $2.50, without tables $2.00.

The alternate edition contains completely new problem lists, a sizable increase in the number of stated problems, and a few minor changes from the first edition of 1942. So two concurrent editions will give instructors a choice of problem material.

The principal objective of the author has been to write a teachable textbook. It should prove especially beneficial to students who have a weak mathematical background and to those who have not yet acquired the habit of orderly and independent thinking. Some of the devices for achieving this objective are:

1. The inclusion of true-false questions test the student's ability to avoid pitfalls and to detect camouflaged truths.
2. Definite instructions are given for proving identities and solving trigono-

metric equations. The subject of identities is approached gradually with practice in algebraic operations with trigonometric functions.
3. A careful explanation of approximations and significant figures is given early in the text.
4. A single rule is given for characteristics of logarithms by using the "standard position" for the decimal point.
5. A simplification of reduction formulas is achieved by using the term "related angle."

The reviewer especially commends the early introduction and emphasis given to identities. However, he questions the advisability of not stating that identities can be proven by assuming the equality is true and manipulating it until an obvious identity is obtained. This is a prevalent error in trigonometry texts. A sampling of nine texts show that six insist on transforming one side only of an identity, or both sides separately. It is granted that most simple identities should be proven by transforming the more complex side only. Practice should also be given in simplifying, by recognizing a trigonometric form, *where the result is not stated;* as for example: $\sin^2 x - \cos^2 x$, $\frac{1}{2}(1-\cos 6x)$, $\sin (x+y) \cos y - \cos (x+y) \sin y$. But it is so much easier to prove

$$\frac{\sin x}{1-\cos x} = \frac{1+\cos x}{\sin x}$$

by the usual procedure for handling proportions, and it is just as good logically.

The interpolation to tenths of a minute, rather than to seconds, is good computational practice. But there does not seem to be enough emphasis given to checking. In several examples of solving triangles the computation of the solution is given in detail, but not the check. It should be pointed out that the sine law is not an adequate check for the solution of Case I by logarithms, as the same logarithms are used in the check as in the solution, so any error in using the tables will not be detected.

It is fine to drill on the theory of logarithms, before the introduction to the tables, by such problems as: If $\log 2 = .30$, find $\log 80$.

There are many excellent problems in airplane navigation, under the assumption of plane sailing, but it would seem advisable to introduce the azimuch angle to describe the course, rather than use the outmoded land surveyor's method of S 20° E.

HAROLD J. WHITE
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ELEMENTS OF ALGEBRA, by Lyman C. Peck, *Department of Mathematics, The Ohio State University,* Cloth. Pages ix+230, $9\frac{1}{4} \times 6\frac{1}{4}$ in. McGraw-Hill Book Company, Inc. New York. 1950. Price $2.75

"This text book is written primarily for college students who have had no algebra in high school and thus presupposes no mathematical background other than ordinary arithmetic."

It is difficult to refrain from discussing the philosophy and the situation which brought such a book into being and to confine a review solely to the mathematical contents of the text. For a text, unlike a treatise, is only good as it helps the student to learn. And it is a question whether the individual who by-passed the study of mathematics from the time he left the grade school until he entered college is capable of what we have been accustomed to regard as college caliber mathematics.

"It is not growing like a tree
In bulk doth make man better be,"

nor is growing in height necessarily a mark of intellectual stature. Just what will the college freshman, without mathematical background to supplement the text, find in this book? The teacher, familiar with the material, will find the change

from orthodox presentation quite refreshing. One has a feeling he would like to try it out on a class—if the class can be found which is capable of clear thinking and has some ability to read. For no matter how simply the principles are phrased, it is difficult to present technical ideas without using technical language.

The author uses simple English, with only occasional lapses into terminology that makes even the seasoned teacher pause and reread, i.e., "To simplify an expression consisting of the sum of terms among which are like terms of various kinds, combine the like terms of each kind by addition and represent the whole sum by the sum of the resulting unlike terms." Most of the time, however, the comments and instructions are given in every day language. "When two quantities are found to have values which depend on each other in some way, their related values are often listed next to each other in a table."

One of the author's avowed aims is "to present algebra as a study of the laws of the number system." With this slant, the familiar four fundamental operations are carried thru the signed numbers and, surprisingly, in such an elementary text, into the realm of the complex number.

The customary employment of letters for words, the creation of a formula out of ideas and the application thereof, in short, the whole technique which grows out of algebraic notation is set forth. Graphing on a point plotting basis is touched upon. Equations, linear up to three unknowns and quadratic in one unknown, are explained with enough factoring to handle the latter by that method as well as by the formula.

Answers to many of the odd numbered problems are given in the back of the book. Listed by chapter and section, they are not as easily located as if listed by page. The printing is clear and not crowded; the paper is of good quality. Italics are used to outline steps in a process or emphasize a rule.

It will be interesting to watch this book, to hear from instructors who are using it, and to know whether it meets a need and ushers in a new trend in college presentation.

A. N. Tucker
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Weltsystem, Weltäther und die Relativitätstheorie, by Prof. Dr. Karl Jellinek (*vormals Direktor des Physikalisch-chemischen Instituts der Technischen Hochschule Danzig*). Wepf & Co., Verlag, Basel. 1949. 450 pages. Sw. fr. 45.

In the introduction Professor Jellinek sets down his ambition. This volume on relativity theory is for the experimentalist. Those written for the theoretical physicist are too severe mathematically; those intended for lay readers are superficial. Calculus and theoretical physics are prerequisites for this text.

Classical physics is first discussed—Newtonian mechanics, light and electromagnetic theory. Then follows a treatment of the special relativity theory with its impact on prerelativistic physics. The general theory follows, with the cosmological problems of Einstein and De Sitter, and the expanding universe. Certain special problems are considered which will appeal to physicists generally —gravitational fields, homogeneous and non-homogeneous, the sun's field, and particular cases of clock synchronization. The problem of the ether is treated but physicists may not generally hold the author's point of view in favor. The book is in German and therefore not too easily adapted to American students, but an ambitious and scholarly doctoral candidate would profit immeasurably from his labor on it.

Julius Sumner Miller
Dillon University
New Orleans, La.

ELECTROMAGNETS OF SPECIAL CONSTRUCTION FOR THE ATTRACTION OF ALUMINUM, COPPER AND OTHER NON-FERROMAGNETIC METALS

Magnetism is one of the most interesting and mysterious as well as one of the most important physical phenomena known. Through its action we generate and utilize the enormous quantities of electrical power which make possible modern industry and modern living. Many important principles of electromagnetism can be understood from the study of an electromagnet, which attracts non-ferromagnetic metals, such as aluminum, silver and copper.

Everyone has experimented with magnets and observed their attraction for iron filings, nails, and other small articles of iron and steel. Some of you will have seen large electromagnets attached to cranes pick up tons of scrap steel and move it about with ease. Tons of iron are held firmly to the magnet with an invisible force and are released by the flip of a switch. You have also observed that while iron is attracted with such force other metals such as aluminum, copper, and silver are unaffected. This principle is often used to separate iron from nonferrous metals. No doubt you have used a magnet to determine whether a nickel plated screw had an iron or brass base. If alternating current is applied to an ordinary electromagnet non-magnetic metals of good electrical conductivity will actually be repelled. In view of all of the above it will be most interesting to learn how magnetism can be used to attract non-ferromagnetic metals.

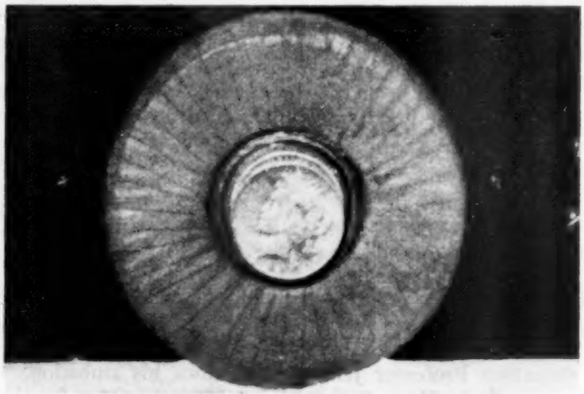

FIG. 1. The magnet supporting silver dollars.

In 1934 the inventor of this new magnet designed equipment with which it was possible to demonstrate the principles whereby non-ferromagnetic metals might be attracted by a special magnet. In 1940 the inventor completed the development and construction of an electromagnet which would attract with considerable force metals such as aluminum, copper and silver. In fact, the magnet would attract any metal of fair or good electrical conductivity. Toward the end of 1947 the author completed the design and construction of a much improved electromagnet for the attraction of non-ferrous metals, illustrations of which are shown herewith. The special electromagnet, Figure 1, with its axis horizontal, shows the magnet supporting two silver dollars. The size of the magnet is illustrated by comparison with the silver dollar.

In order to explain and illustrate the theory of operation, design, and construction of electromagnets for the attraction of non-ferrous metals the Scientific Book Publishing Company, of Vincennes, Indiana have published a book. The inventor of the electromagnet is also the author of this book. The book is profusely illustrated with over fifty (50) drawings and illustrations. Ask for free bulletin No. E-15.